Power Assoc. of Northern California

Climate Change (and energy bills)
The Problems are the US and China
A Partial Solution is California

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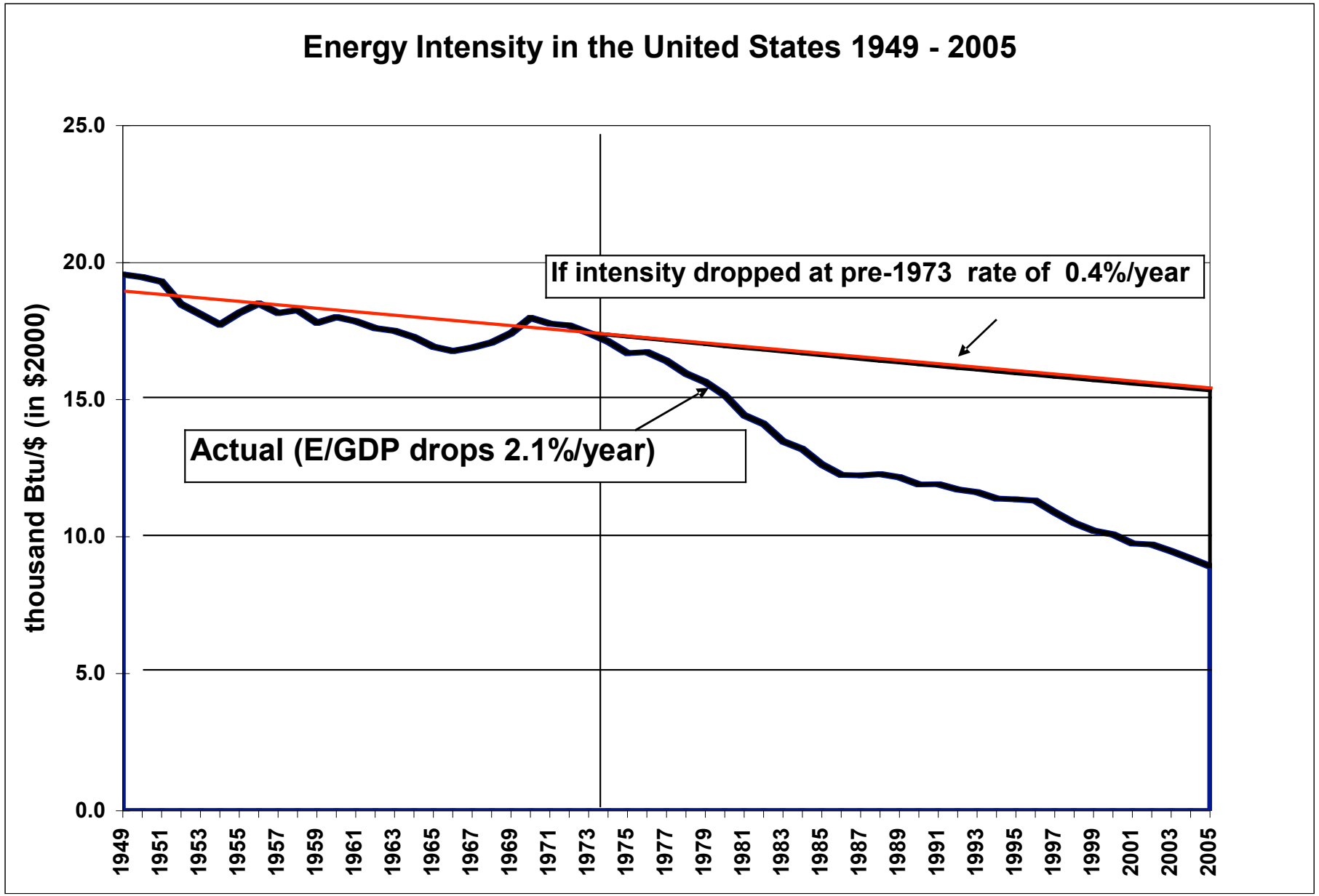
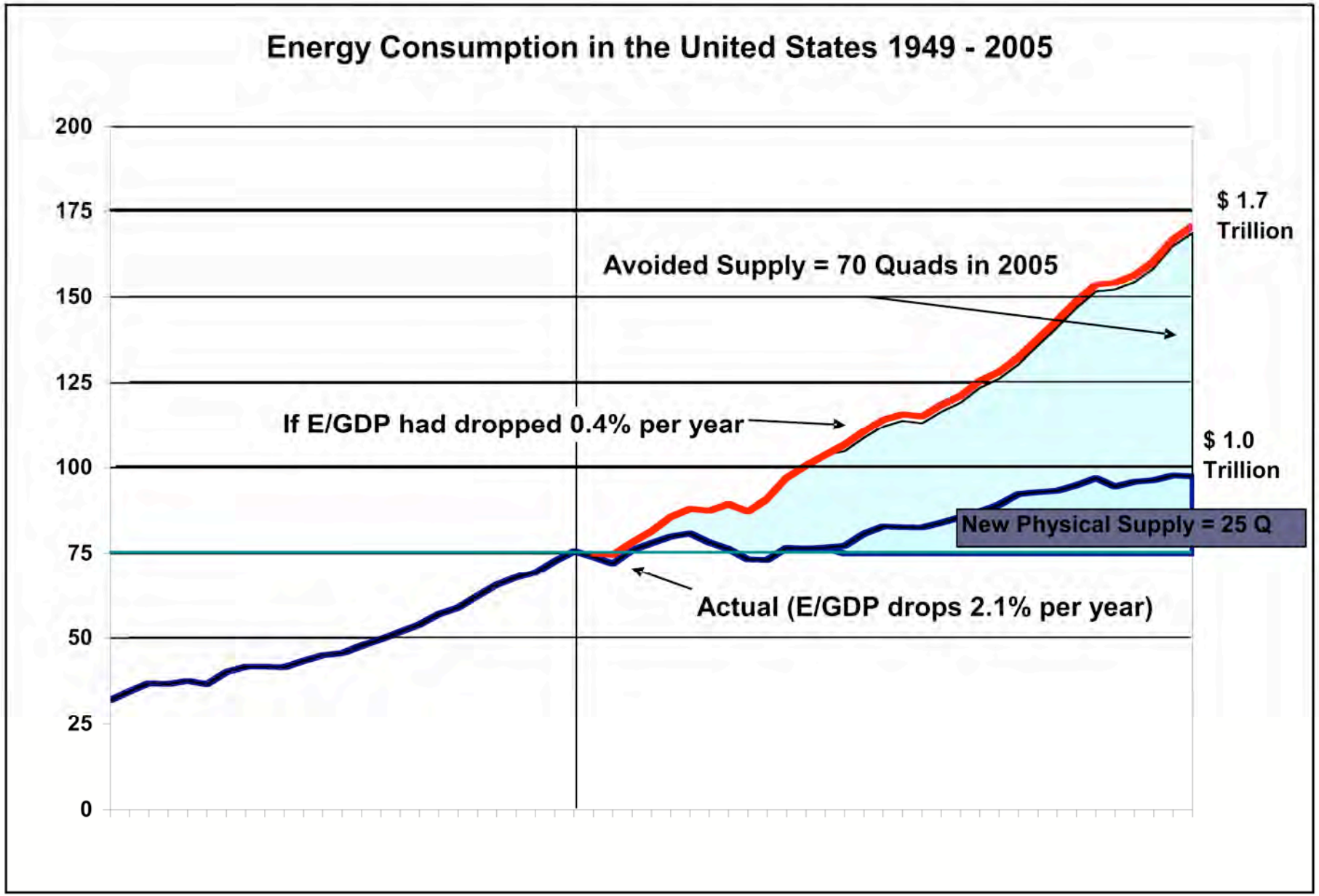
1949

Rosenfeld

Nuclear Physics

A Course Given by **ENRICO FERMI**
at the University of Chicago. Notes Compiled by
Jay Orear, A. H. Rosenfeld, and R. A. Schluter


Energy Intensity in the United States 1949 - 2005
thousand Btu/$ (in $2000)
25.0
20.0
15.0
10.0
5.0
0.0
If intensity dropped at pre-1973 rate of 0.4%/year
Actual (E/GDP drops 2.1%/year)
1949
1951
1953
1955
1957
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005


Energy Consumption in the United States 1949 - 2005
200
175
150
125
100
75
50
25
0
$ 1.7 Trillion
Avoided Supply = 70 Quads in 2005
If E/GDP had dropped 0.4% per year
$ 1.0 Trillion
New Physical Supply = 25 Q
Actual (E/GDP drops 2.1% per year)

How Much of The Savings Come from Efficiency?

- Easiest to tease out is cars
  - In the early 1970s, only 14 miles per gallons
  - Now about 21 miles per gallon
  - If still at 14 mpg, we'd consume **75 billion gallons more** and pay **$225 Billion more** at 2006 prices
  - But we still pay **$450 Billion per year**
  - If California wins the "Schwarzenegger-Pavley" suit, and it is implemented nationwide, we'll save **another $150 Billion per year**
- Commercial Aviation improvements save another **$50 Billion per year**
- Appliances and Buildings are more complex
  - We must sort out true efficiency gains vs. structural changes (from smokestack to service economy).

How Much of The Savings Come from Efficiency (cont'd)?

- Some examples of estimated savings in 2006 based on 1974 efficiencies minus 2006 efficiencies

	Billion $
Space Heating	40
Air Conditioning	30
Refrigerators	15
Fluorescent Tube Lamps	5
Compact Floursecent Lamps	5
Total	**95**

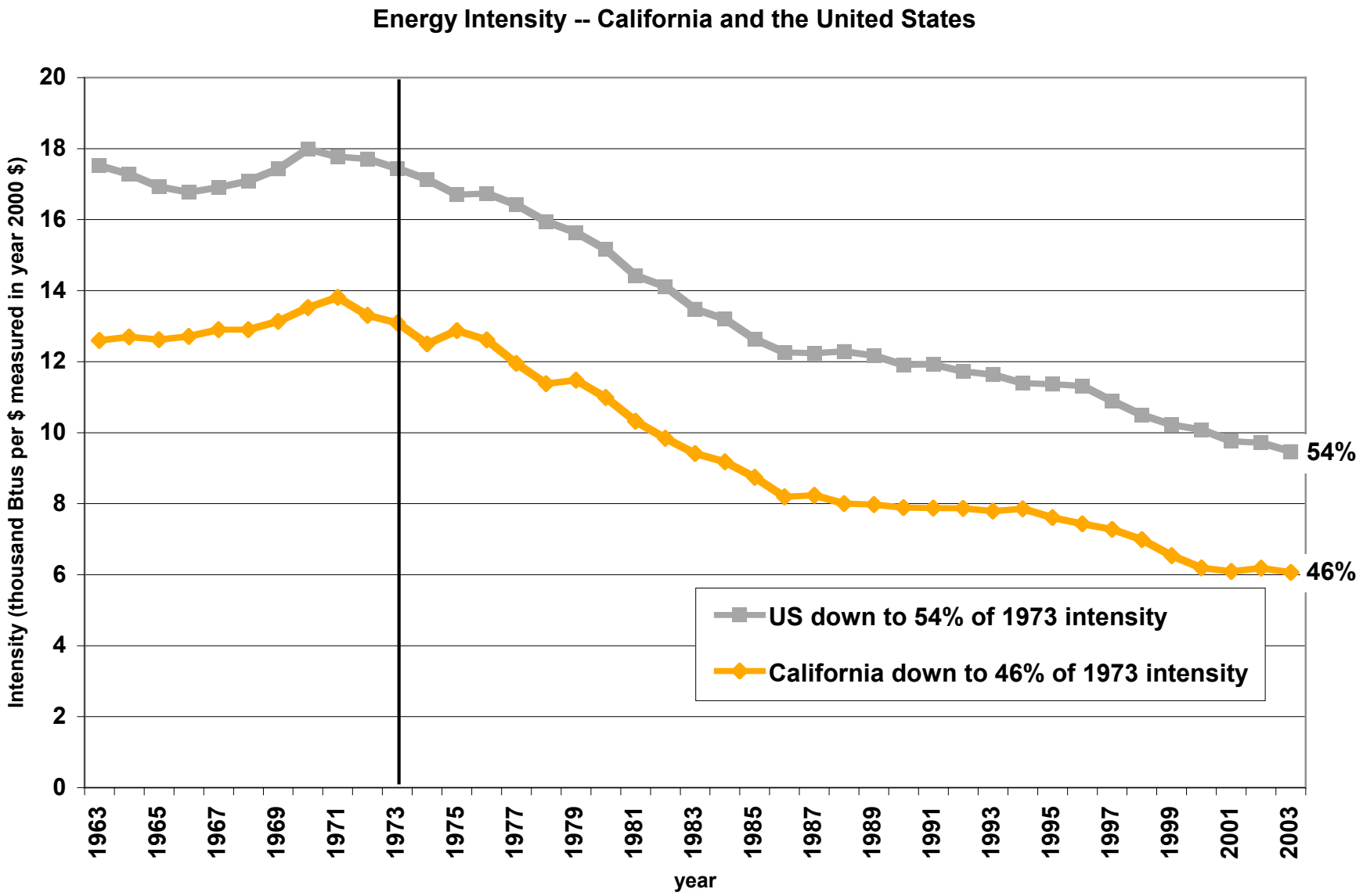
- Beginning in 2007 in California, reduction of "vampire" or stand-by losses
  - This will save $10 Billion when finally implemented, nation-wide
- Out of a total **$700 Billion**, a crude summary is that 1/3 is structural, 1/3 is transportation, and 1/3 is buildings and industry.

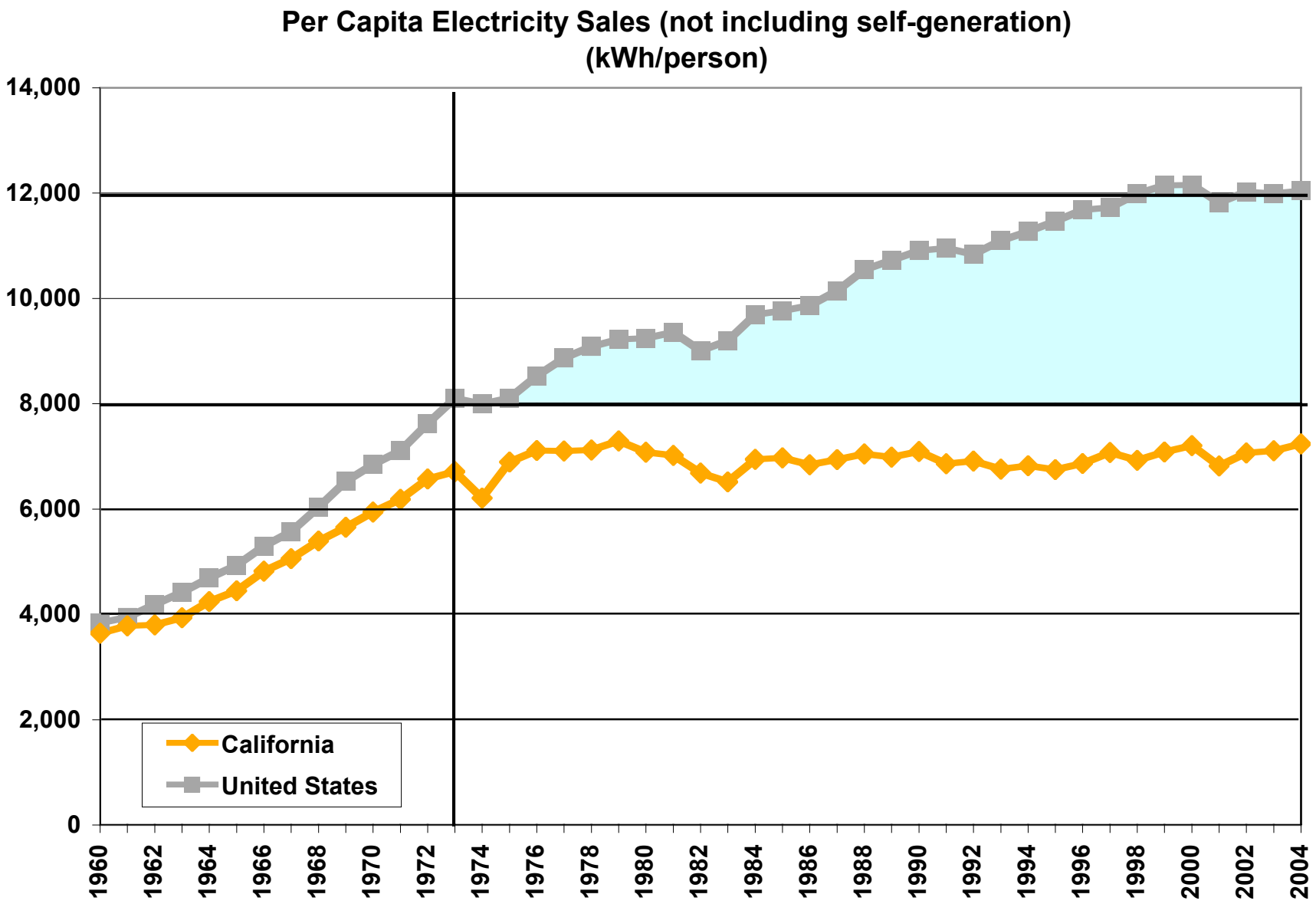
A supporting analysis on the topic of efficiency from Vice-President Dick Cheney

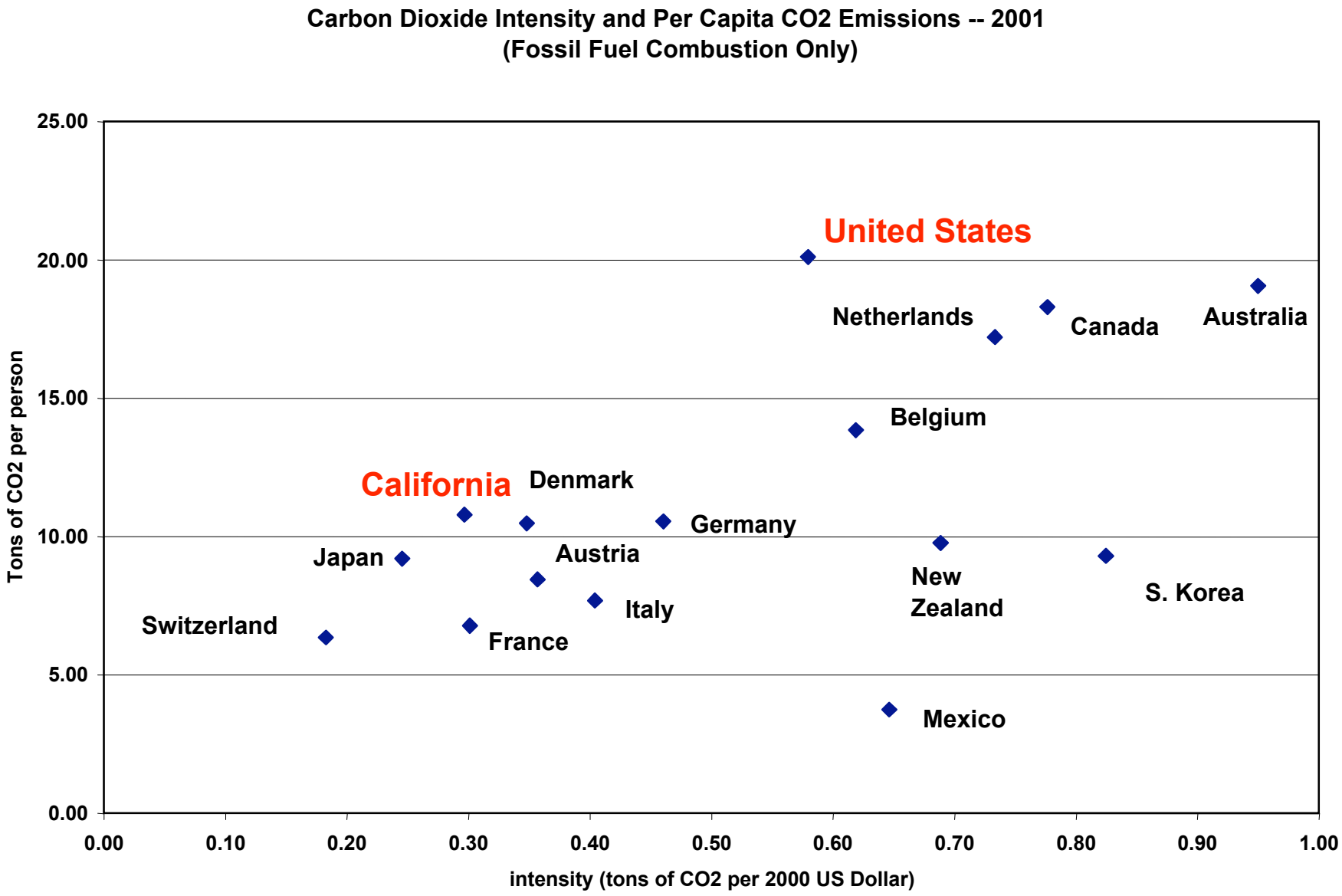
- "Had energy use kept pace with economic growth, the nation would have consumed 171 quadrillion British thermal units (Btus) last year instead of 99 quadrillion Btus"
- "About a third to a half of these savings resulted from shifts in the economy. The other half to two-thirds resulted from greater energy efficiency"

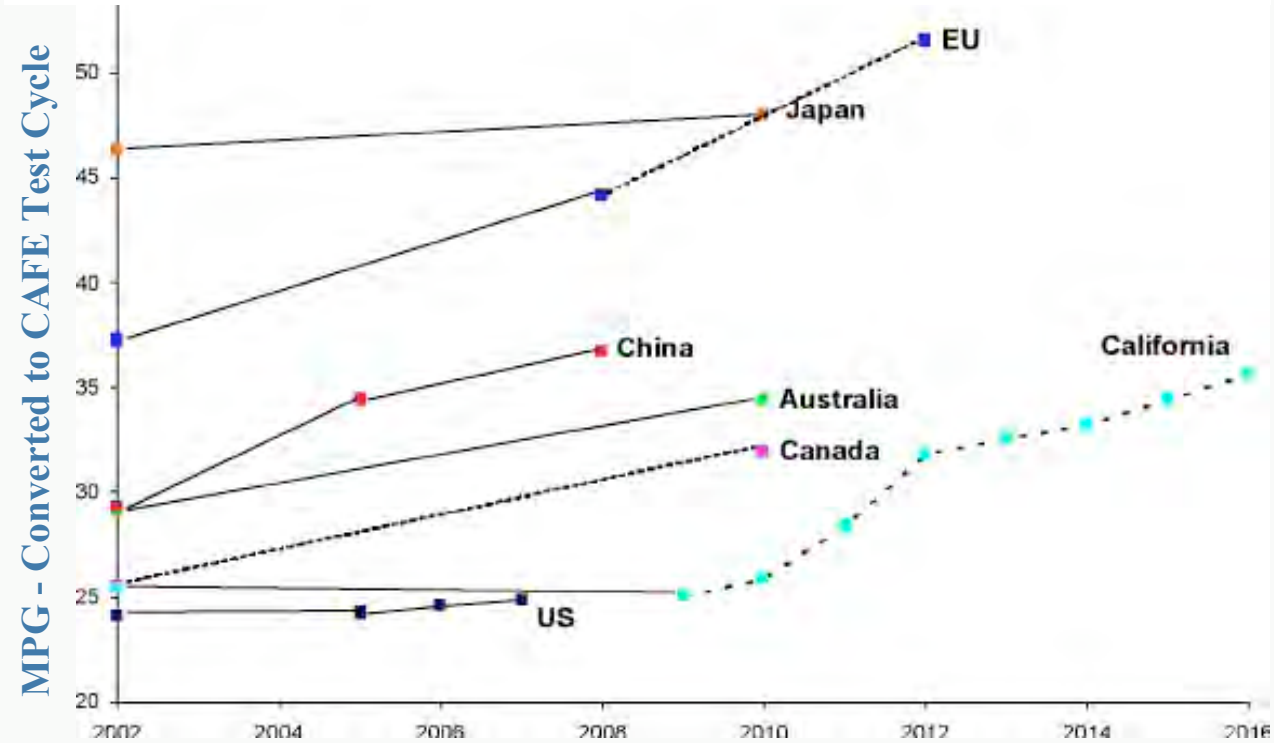
Source: National Energy Policy: Report of the National Energy Policy Development Group, Dick Cheney, et. al., page 1-4, May 2001

Cheney could have noted that 72 quads/year saved in the US alone, would fuel one Billion cars, compared to a world car count of only 600 Million

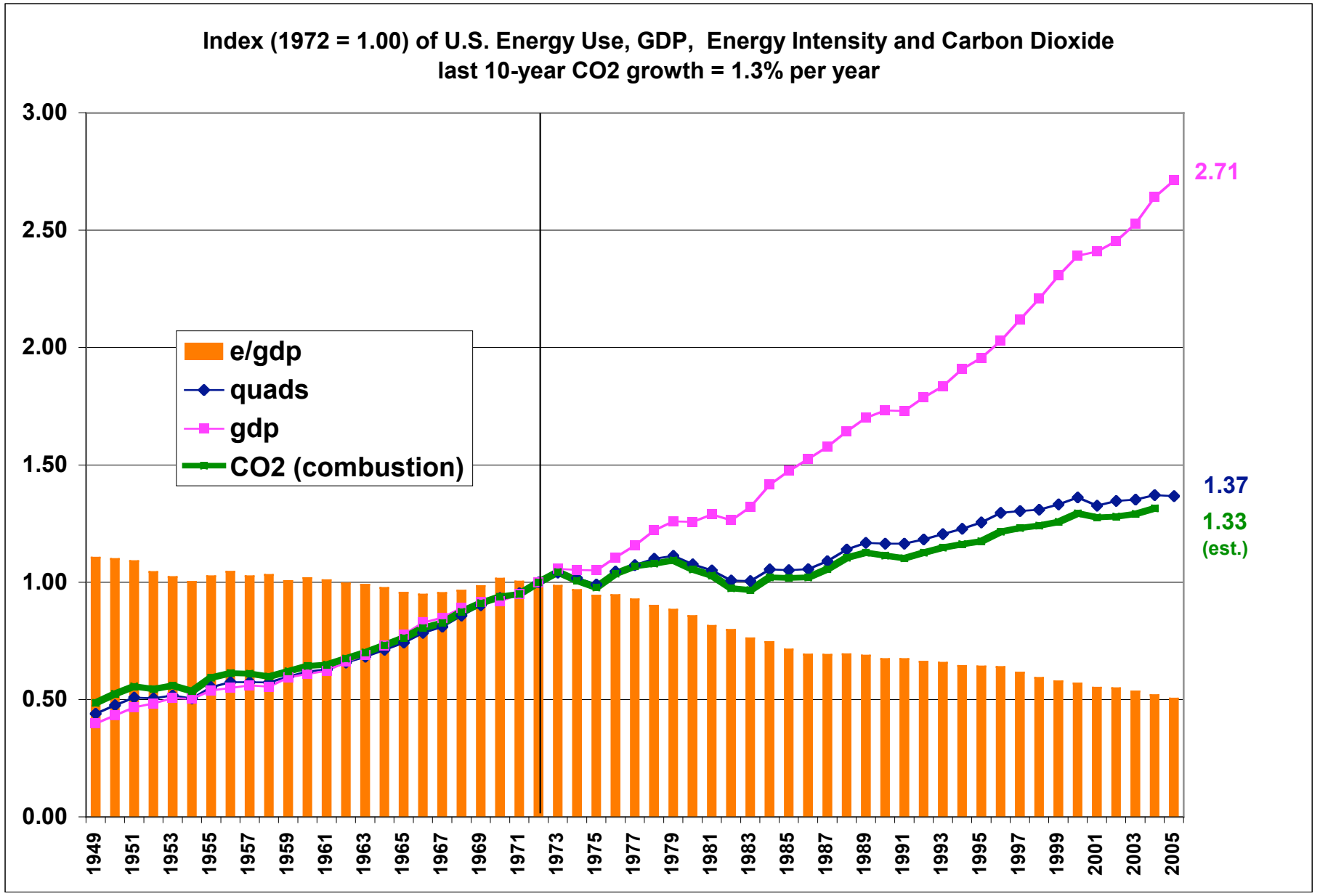

Energy Intensity -- California and the United States
Intensity (thousand Btus per $ measured in year 2000 $)
20
18
16
14
12
10
8
6
4
2
0
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
year
54%
46%
US down to 54% of 1973 intensity
California down to 46% of 1973 intensity


Per Capita Electricity Sales (not including self-generation)
(kWh/person)
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
California
United States


Carbon Dioxide Intensity and Per Capita CO2 Emissions -- 2001
(Fossil Fuel Combustion Only)
Tons of CO2 per person
25.00
20.00
15.00
10.00
5.00
0.00
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
intensity (tons of CO2 per 2000 US Dollar)
United States
Netherlands
Canada
Australia
Belgium
California
Denmark
Germany
Japan
Austria
New Zealand
S. Korea
Italy
Switzerland
France
Mexico

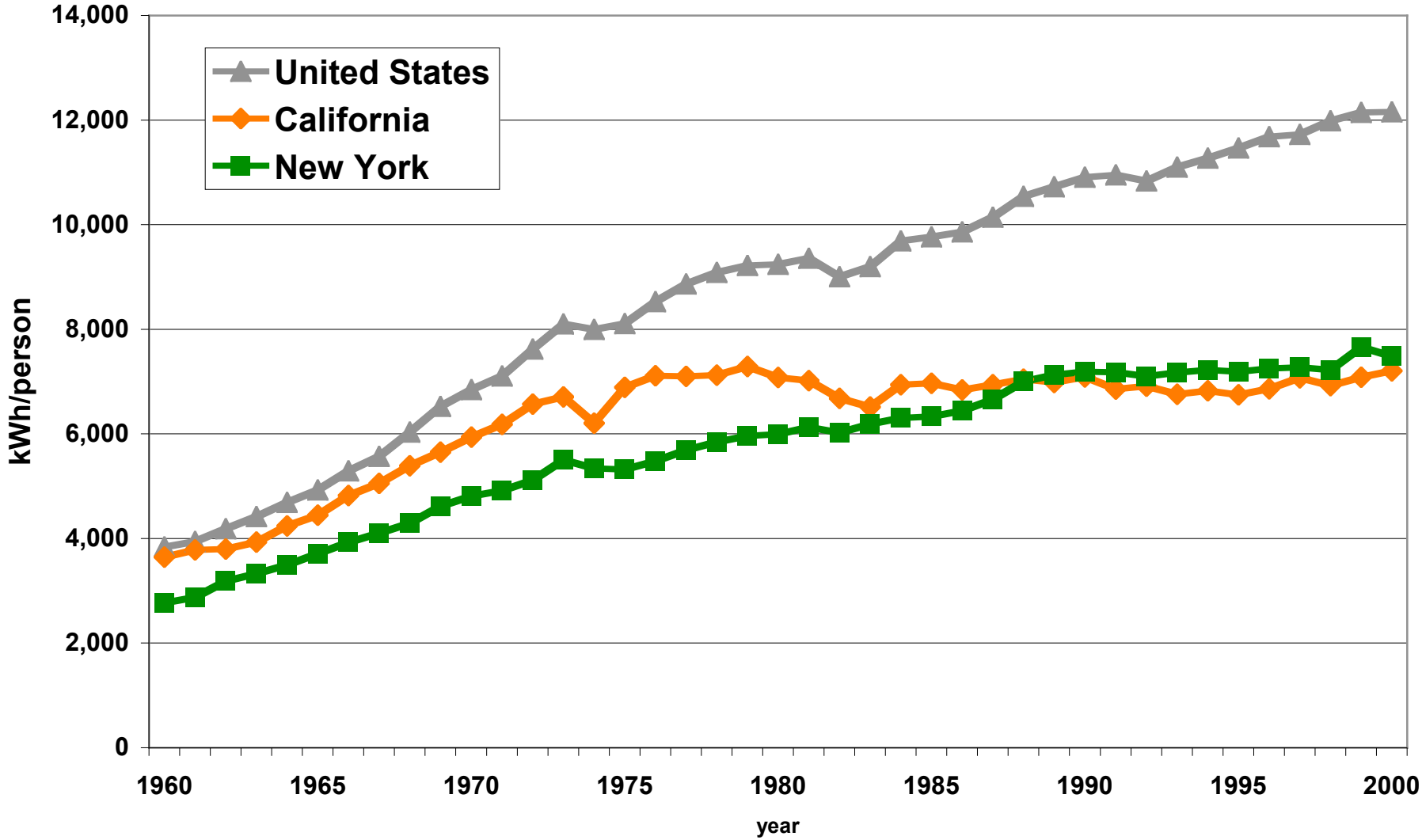


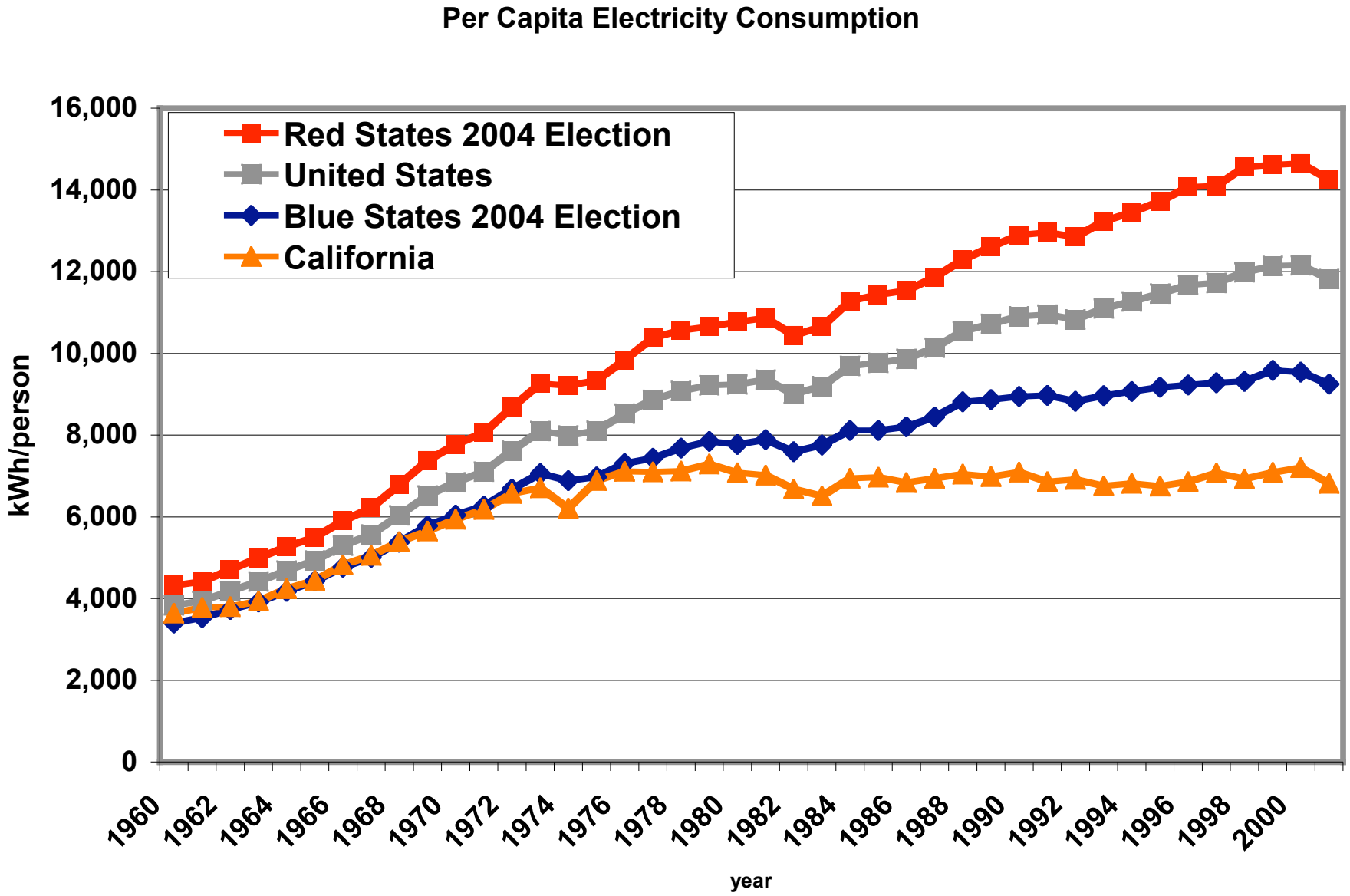
(1) dotted lines denote proposed standards
(2) MPG = miles per gallon


Index (1972 = 1.00) of U.S. Energy Use, GDP, Energy Intensity and Carbon Dioxide
last 10-year CO2 growth = 1.3% per year
3.00
2.50
2.00
1.50
1.00
0.50
0.00
e/gdp
quads
gdp
CO2 (combustion)
2.71
1.37
1.33
(est.)
1949
1951
1953
1955
1957
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005

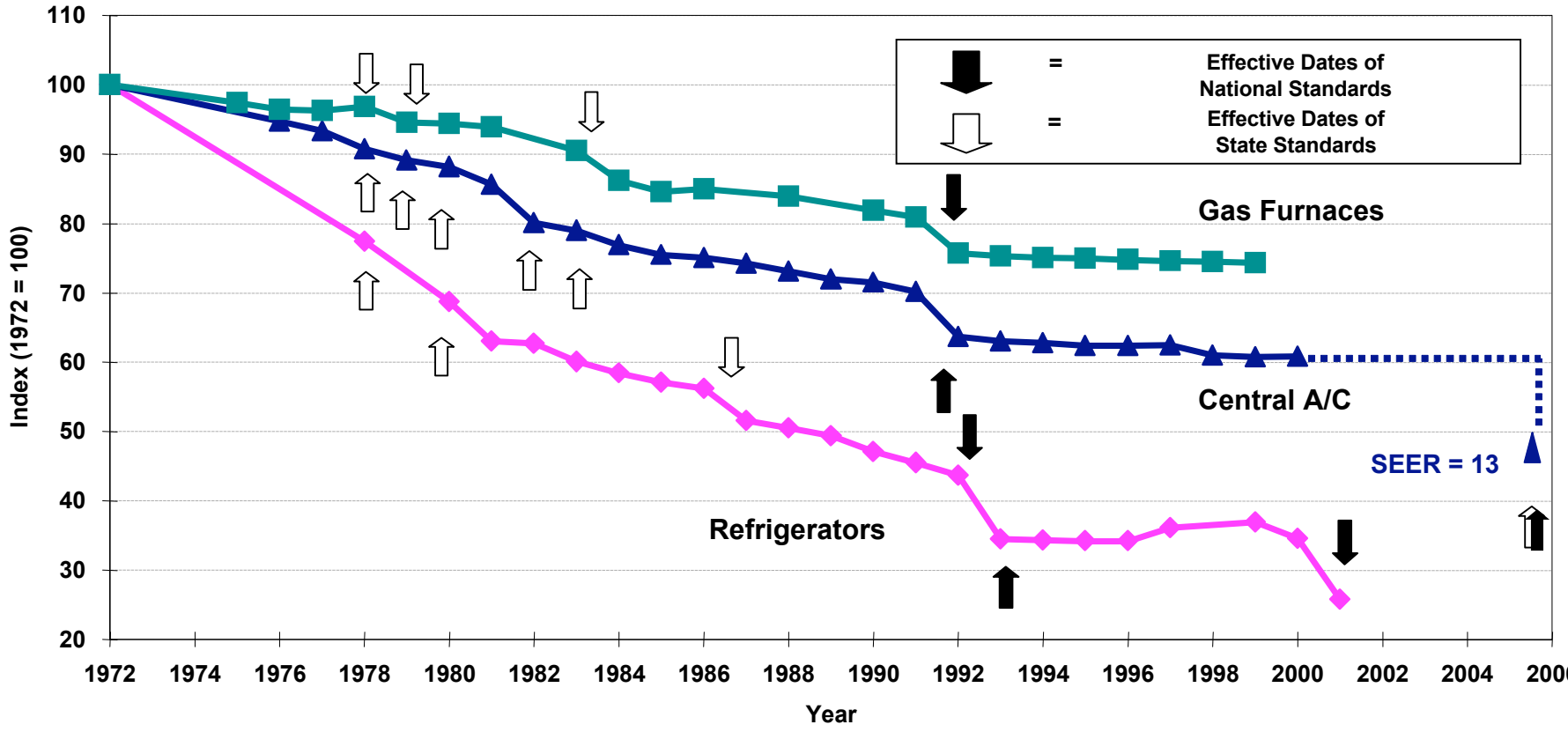
Per Capita Electricity Consumption

Source: http://www.eia.doe.gov/emeu/states/sep_use/total/csv/use_csv




Per Capita Electricity Consumption
Red States 2004 Election
United States
Blue States 2004 Election
California
kWh/person
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
year

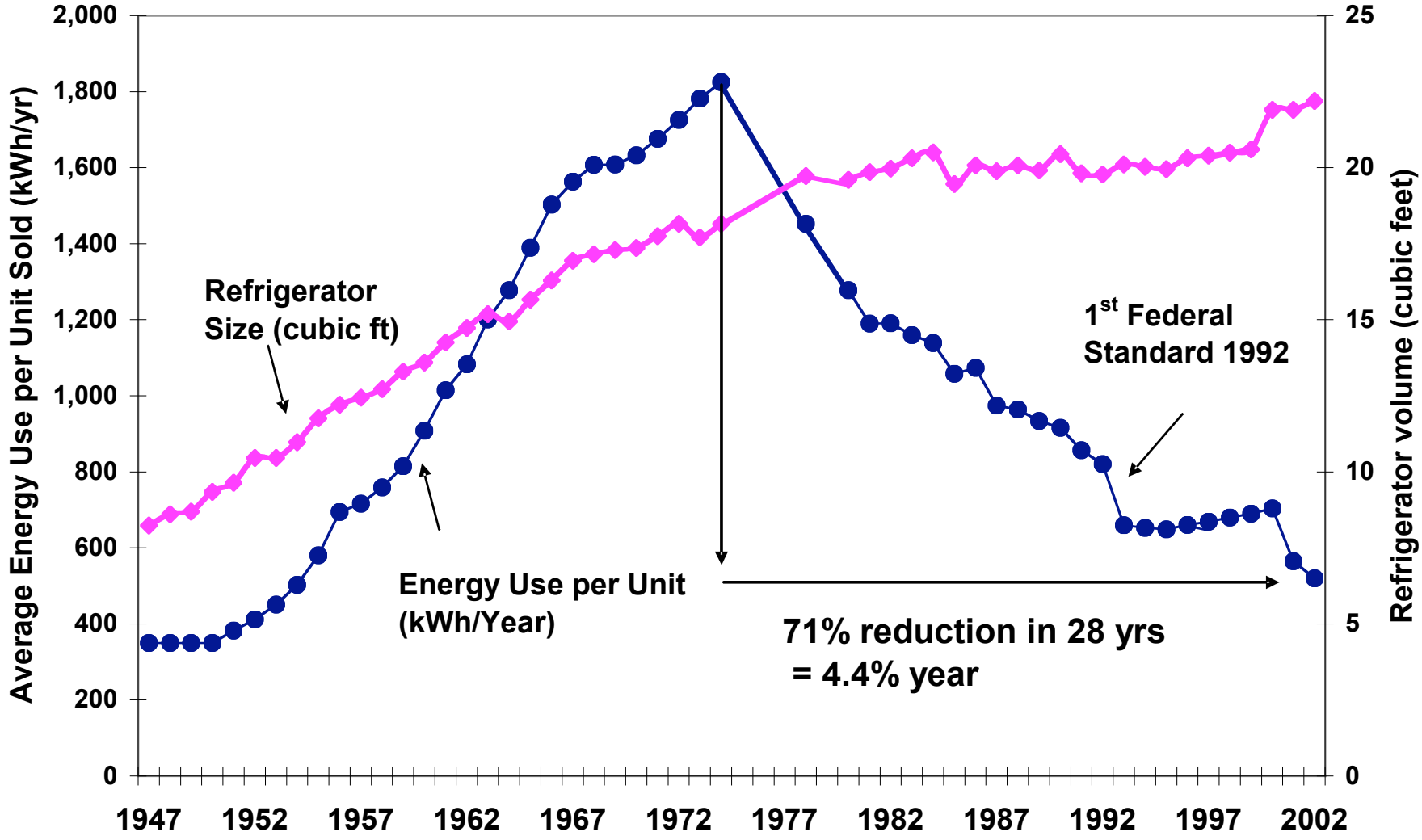
Impact of Standards on Efficiency of 3 Appliances



Source: S. Nadel, ACEEE,

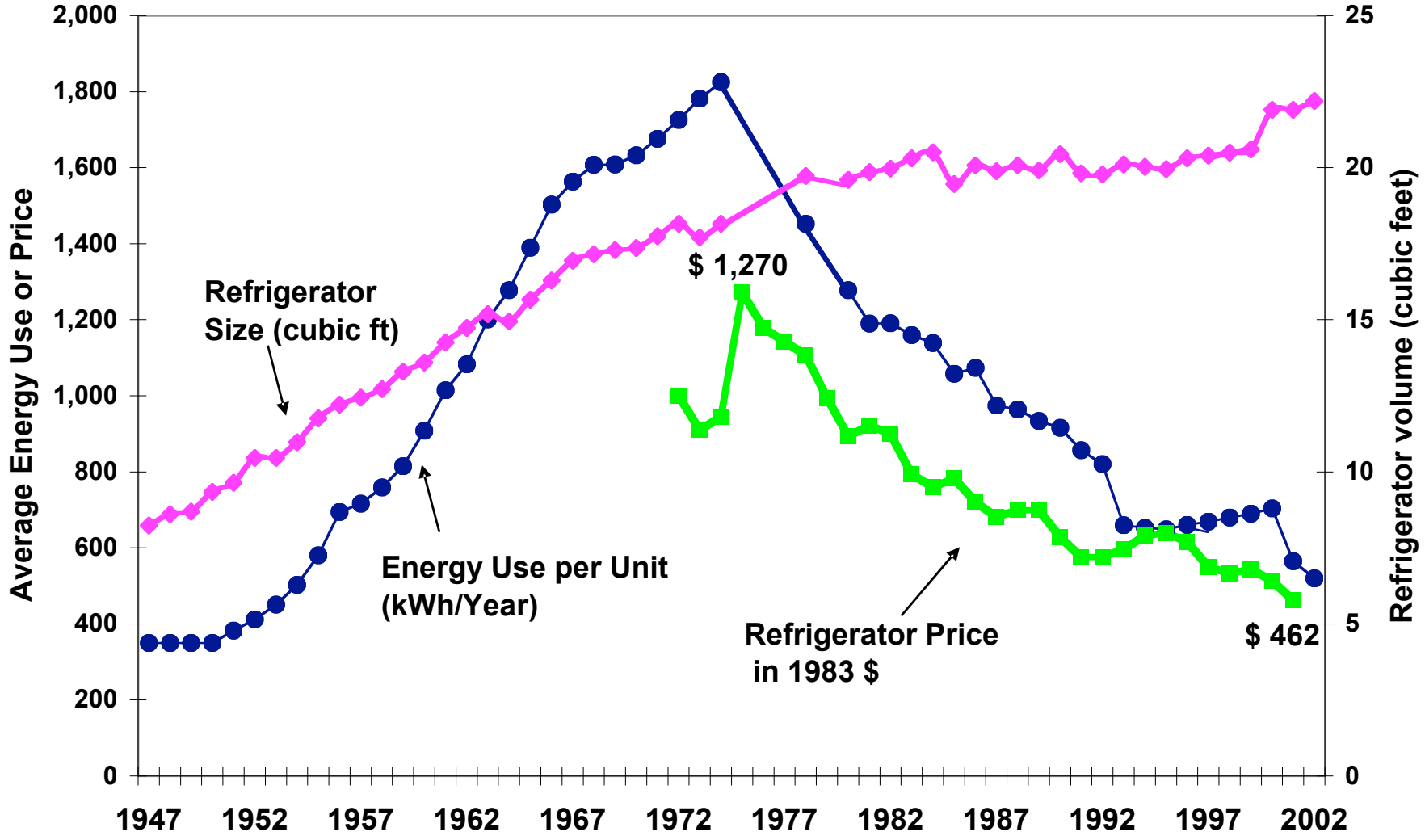
in ECEEE 2003 Summer Study, www.eceee.org

New United States Refrigerator Use v. Time



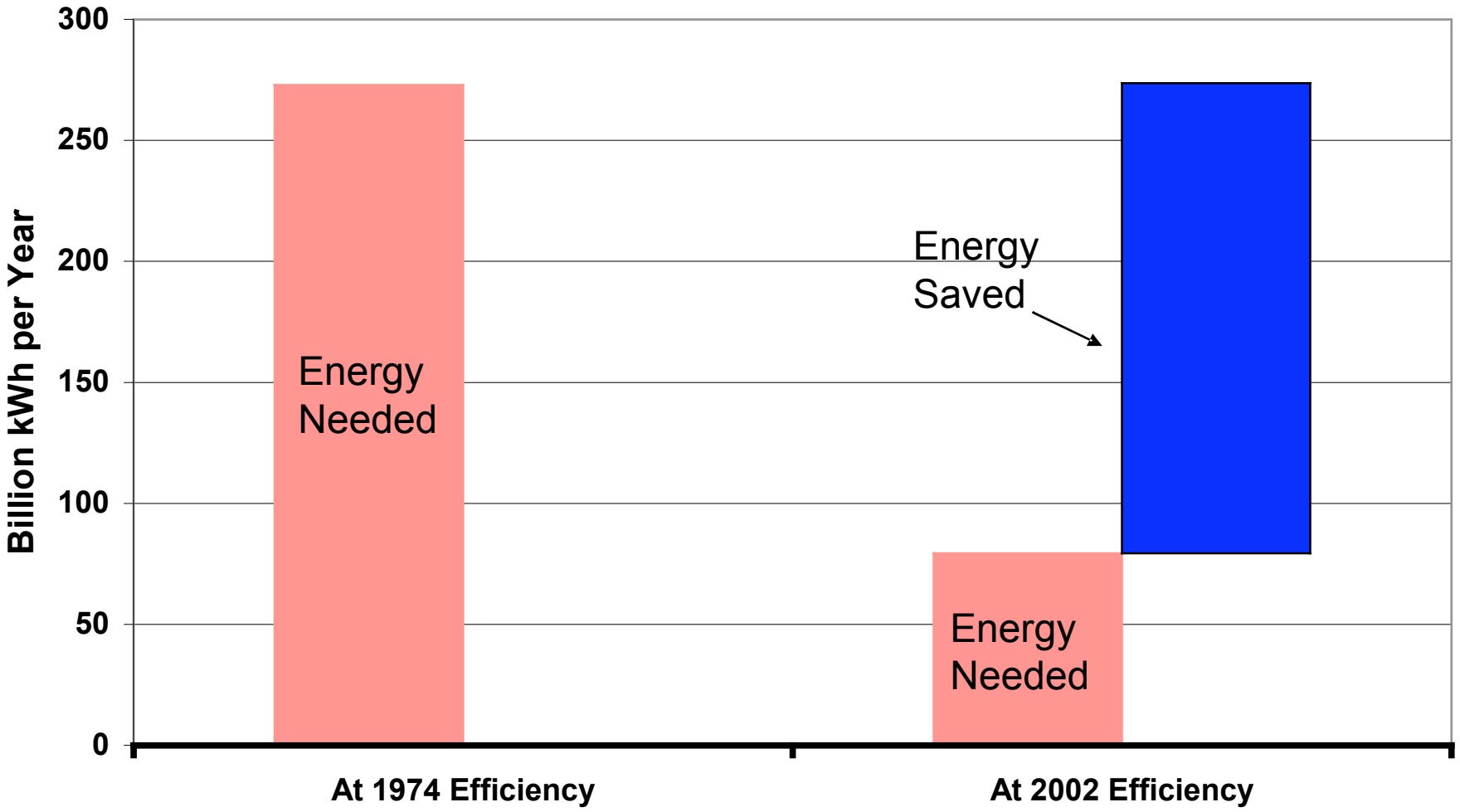
Source: David Goldstein

New United States Refrigerator Use v. Time and Retail Prices

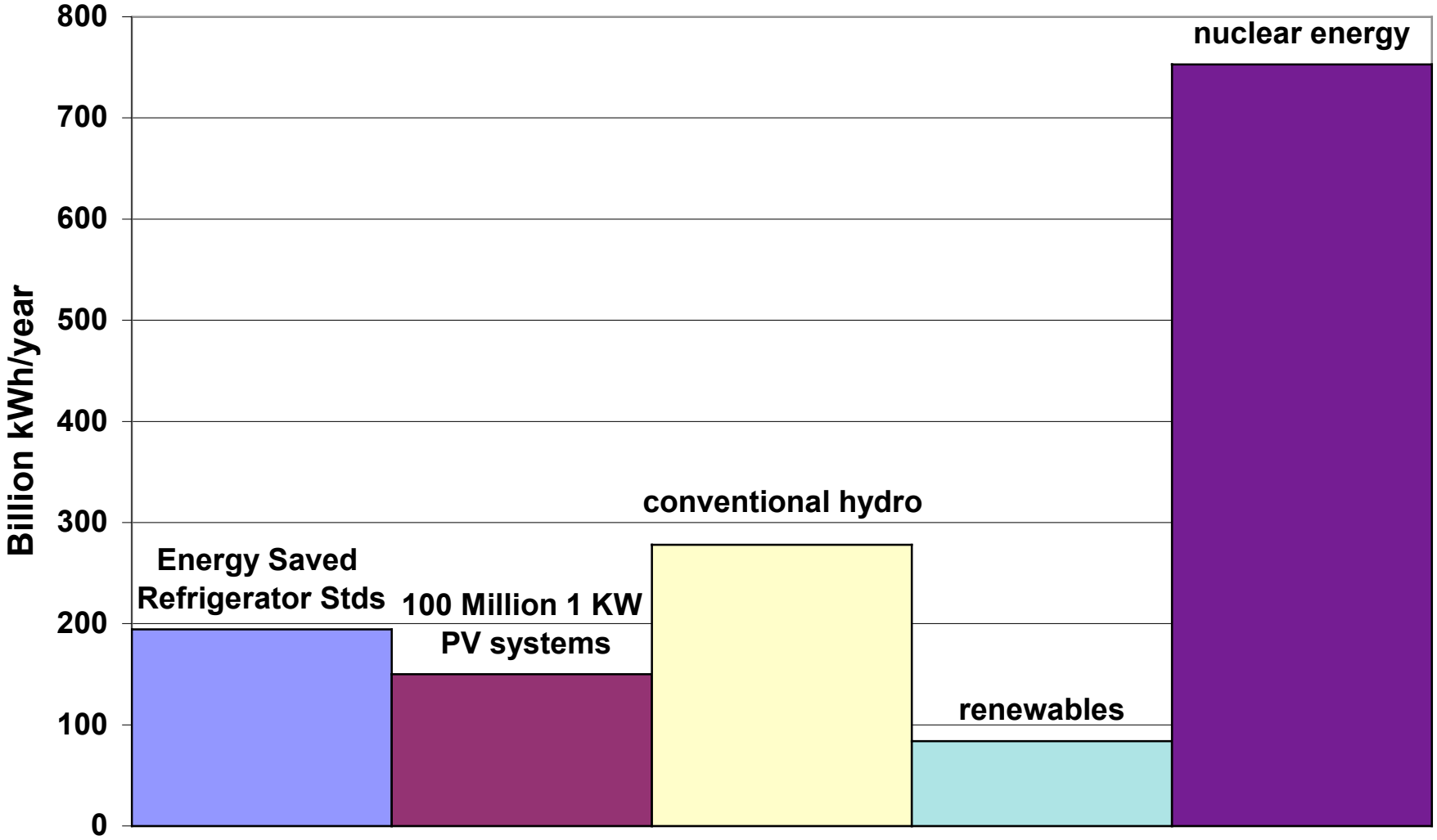


Source: David Goldstein

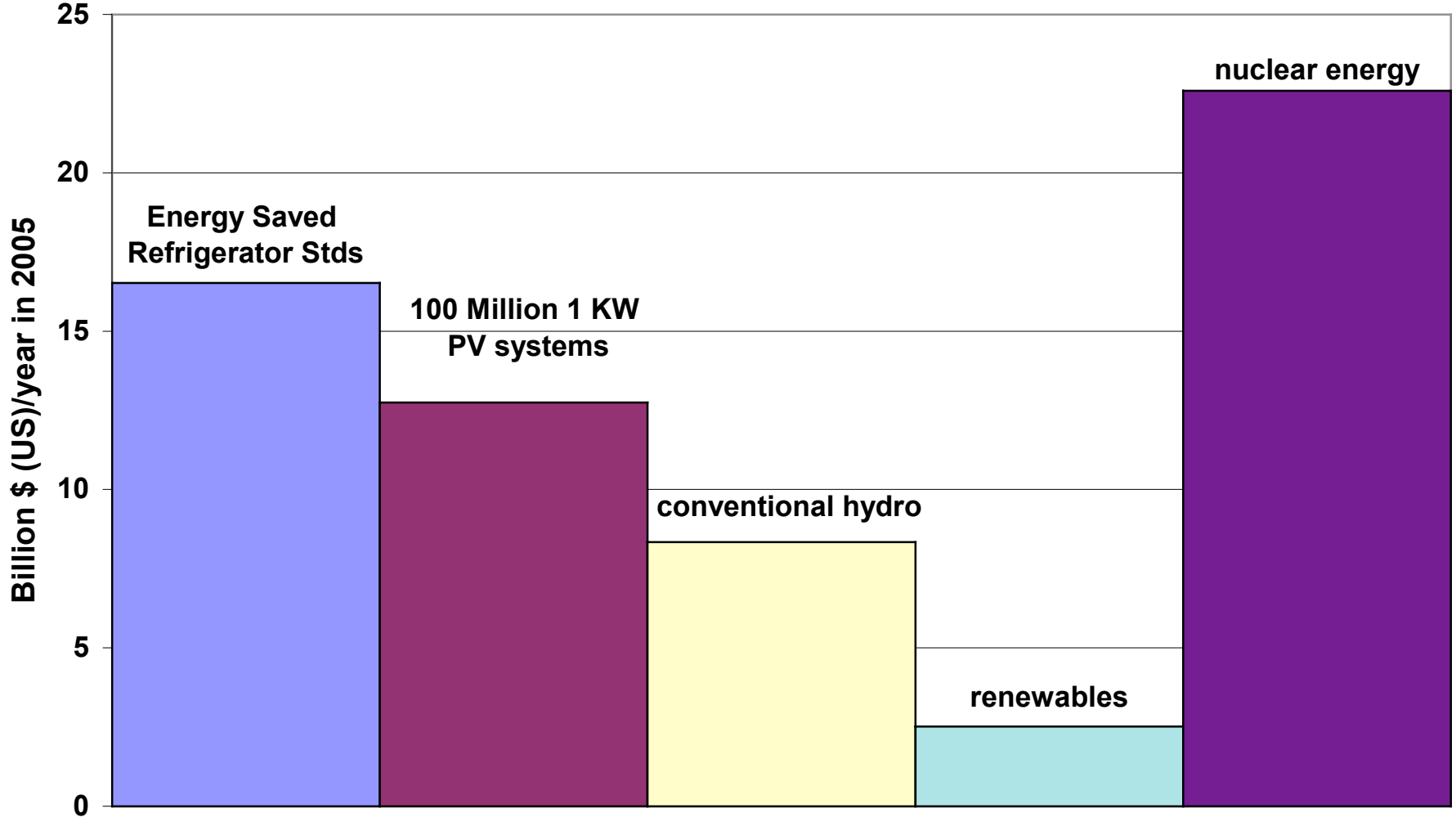
New Refrigerator Energy Use: 71% will be saved when stock completely turns over to 2001 Standards



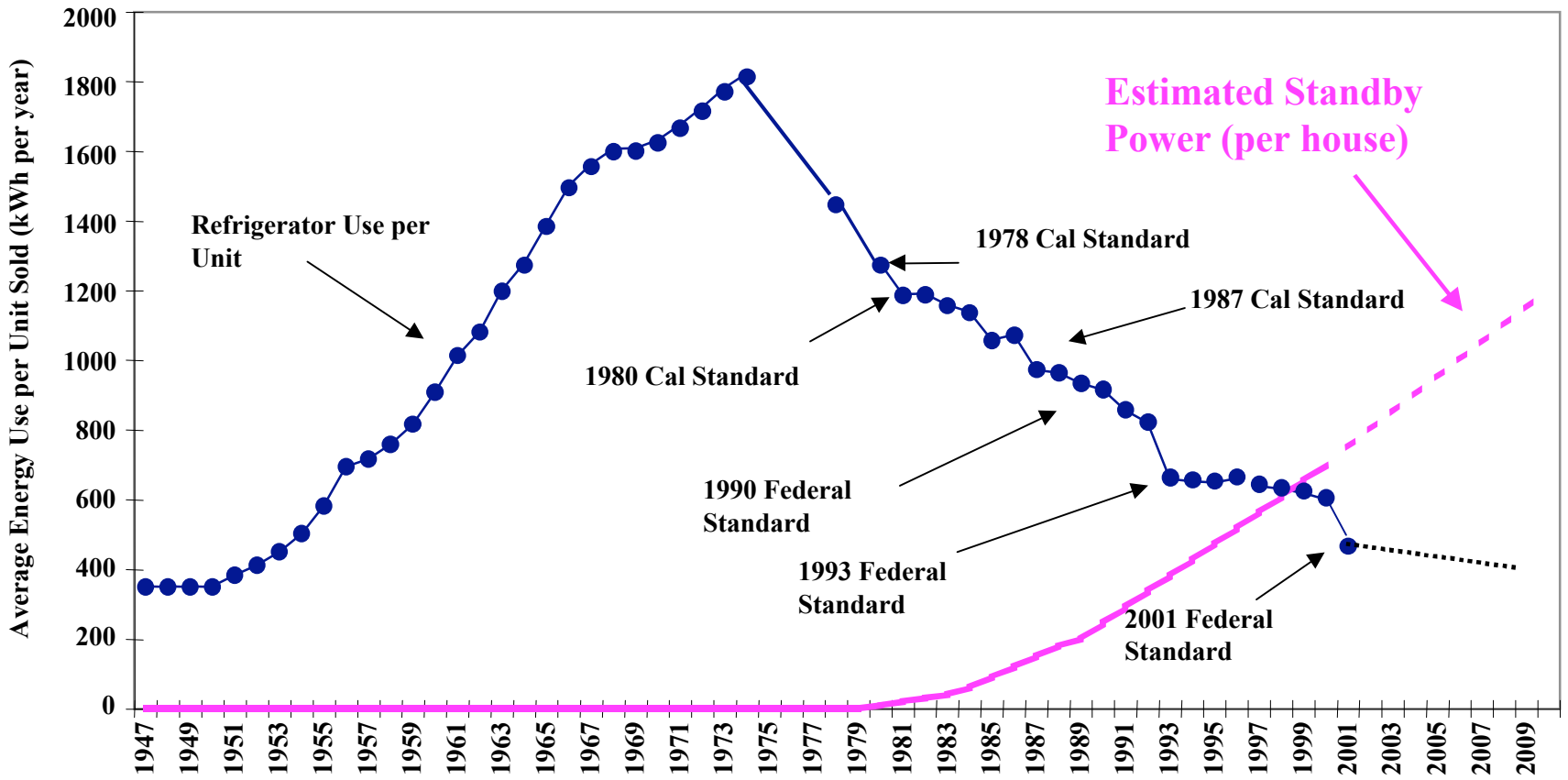
Annual Energy Saved vs. Several Sources of Supply



Value of Energy to be Saved (at 8.5 cents/kWh, retail price) vs. Several Sources of Supply in 2005 (at 3 cents/kWh, wholesale price)

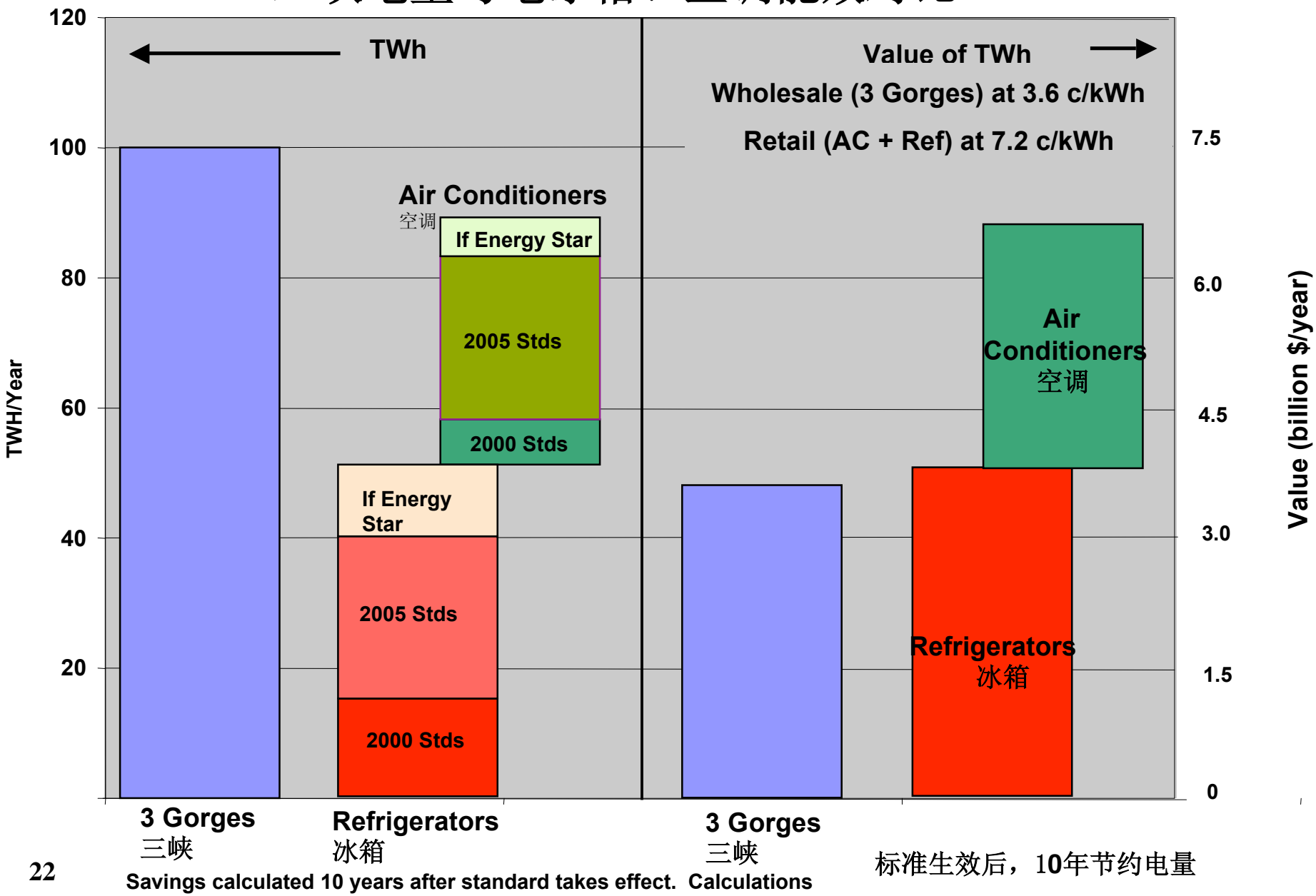


United States Refrigerator Use, repeated, to compare with Estimated Household Standby Use v. Time



Comparison of 3 Gorges to Refrigerator and AC Efficiency Improvements

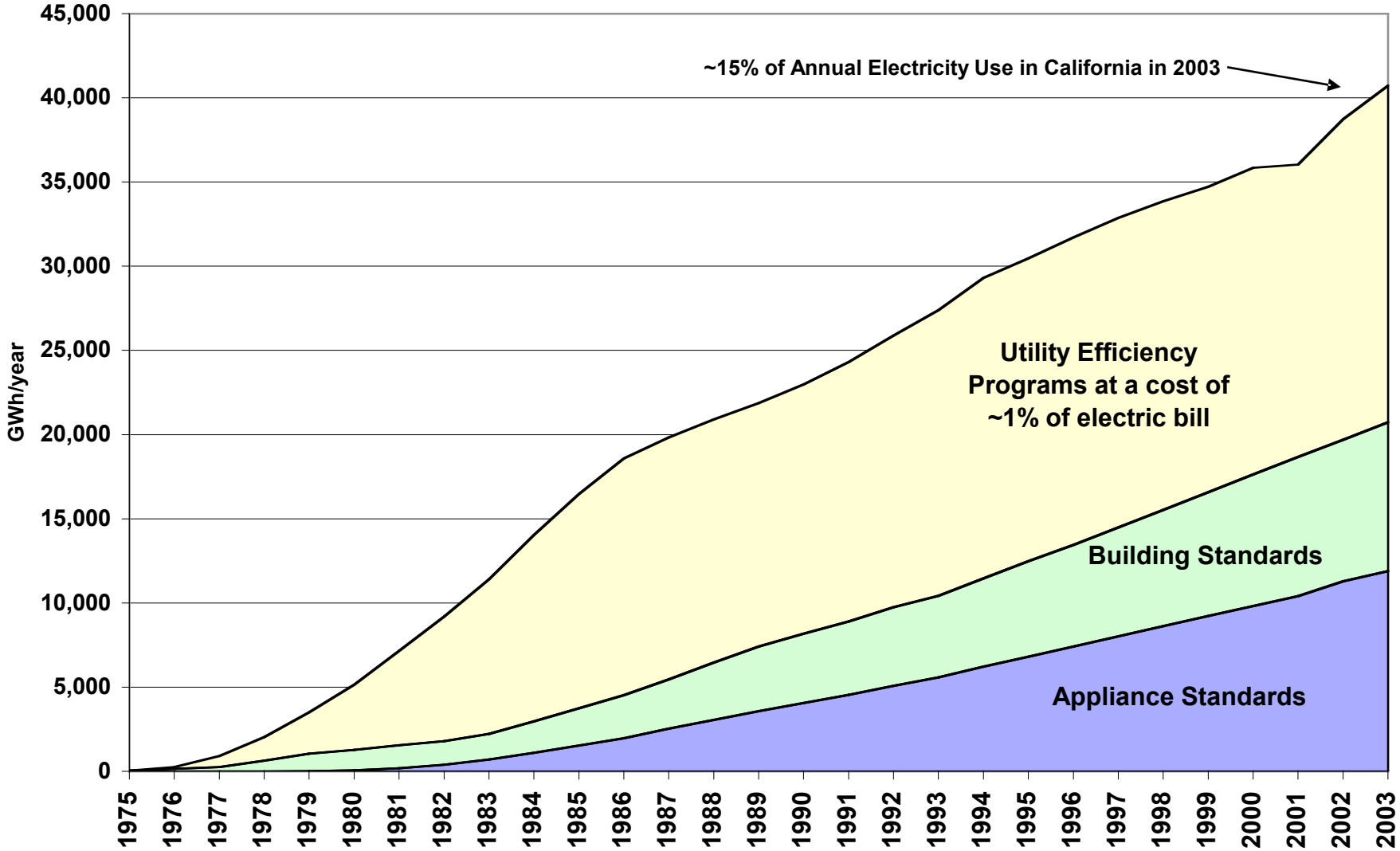
三峡电量与电冰箱、空调能效对比



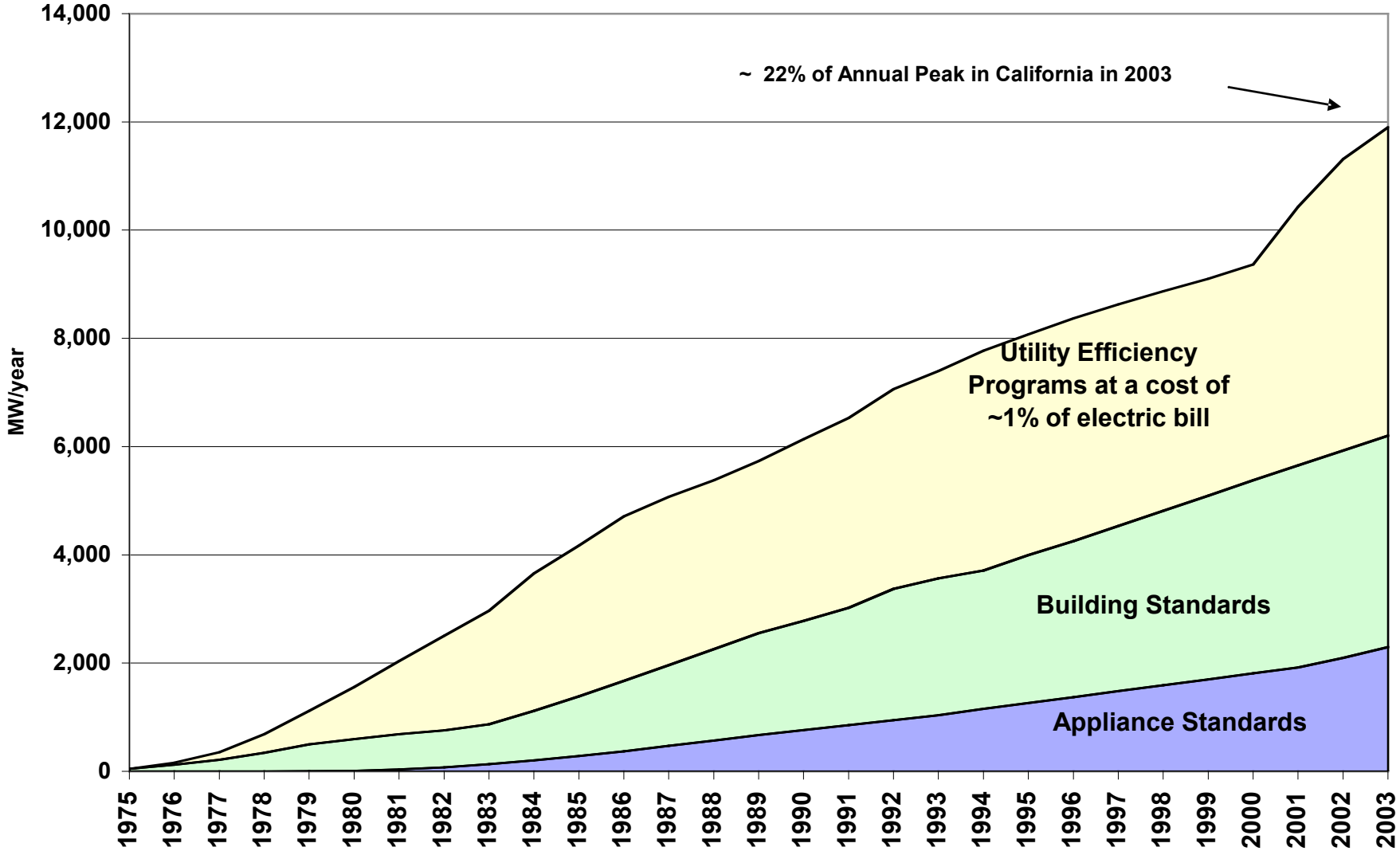
Savings calculated 10 years after standard takes effect. Calculations provided by David Fridley, LBNL

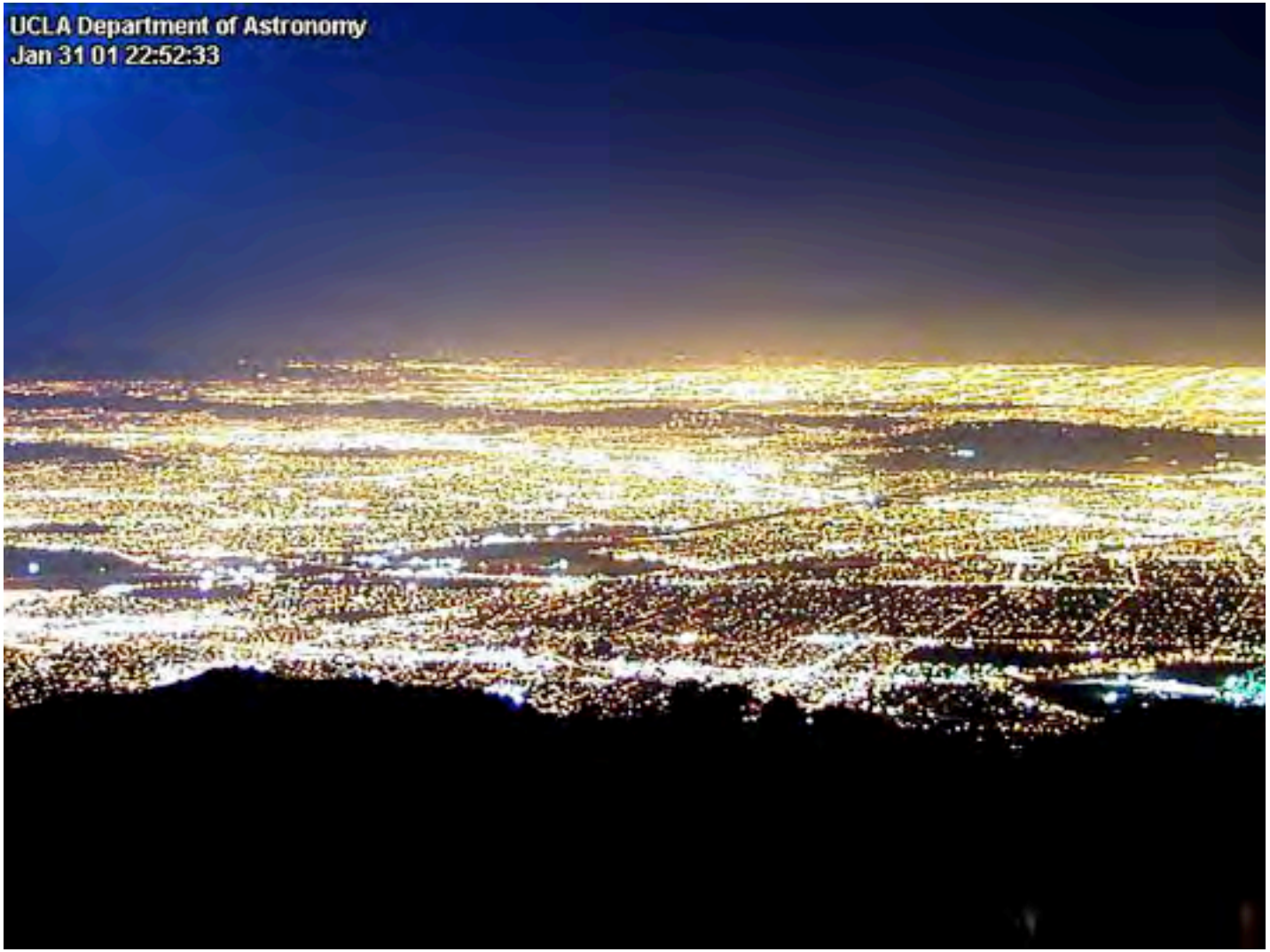
标准生效后，10年节约电量

Annual Energy Savings from Efficiency Programs and Standards



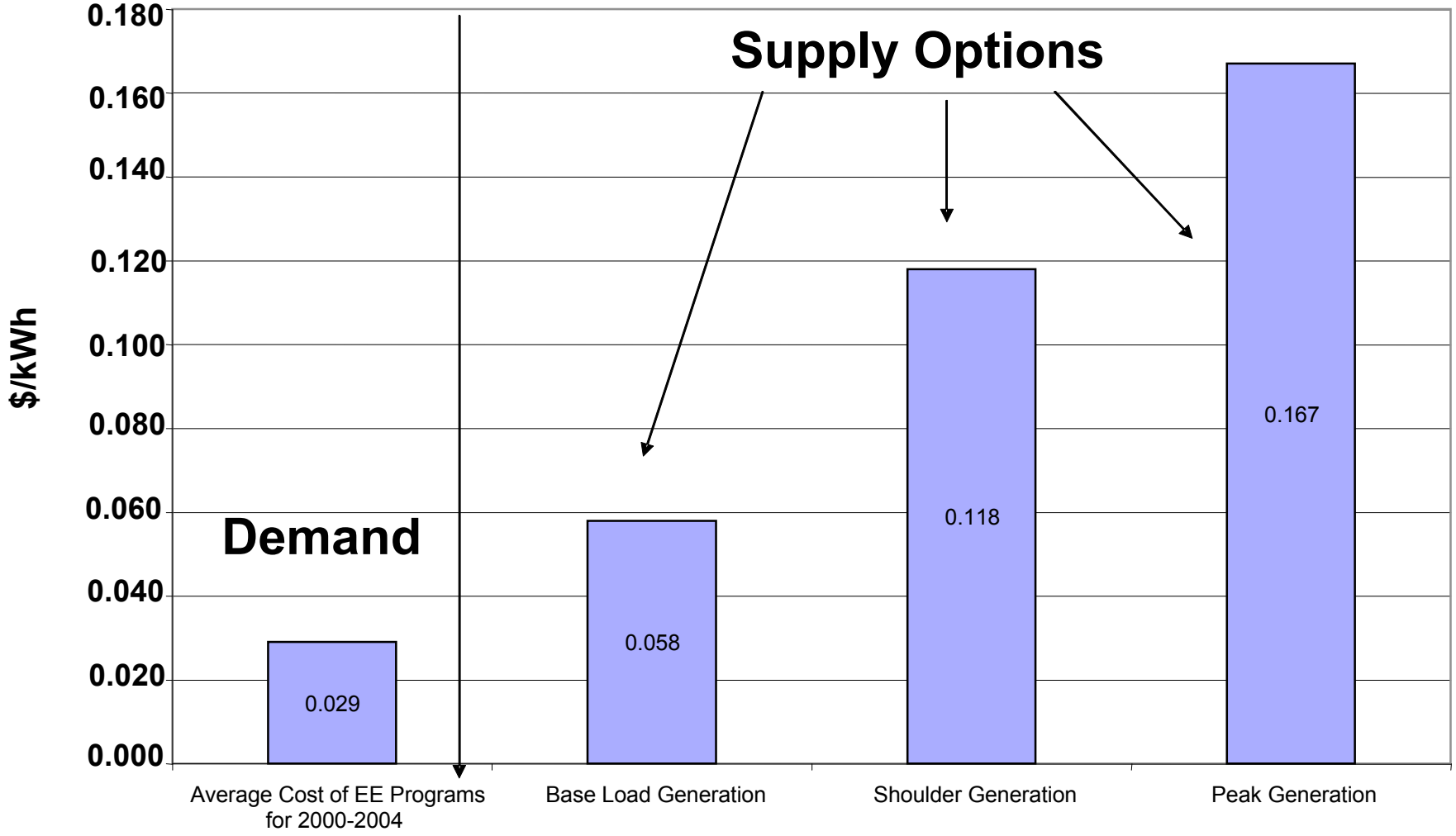
Annual Peak Savings from Efficiency Programs and Standards



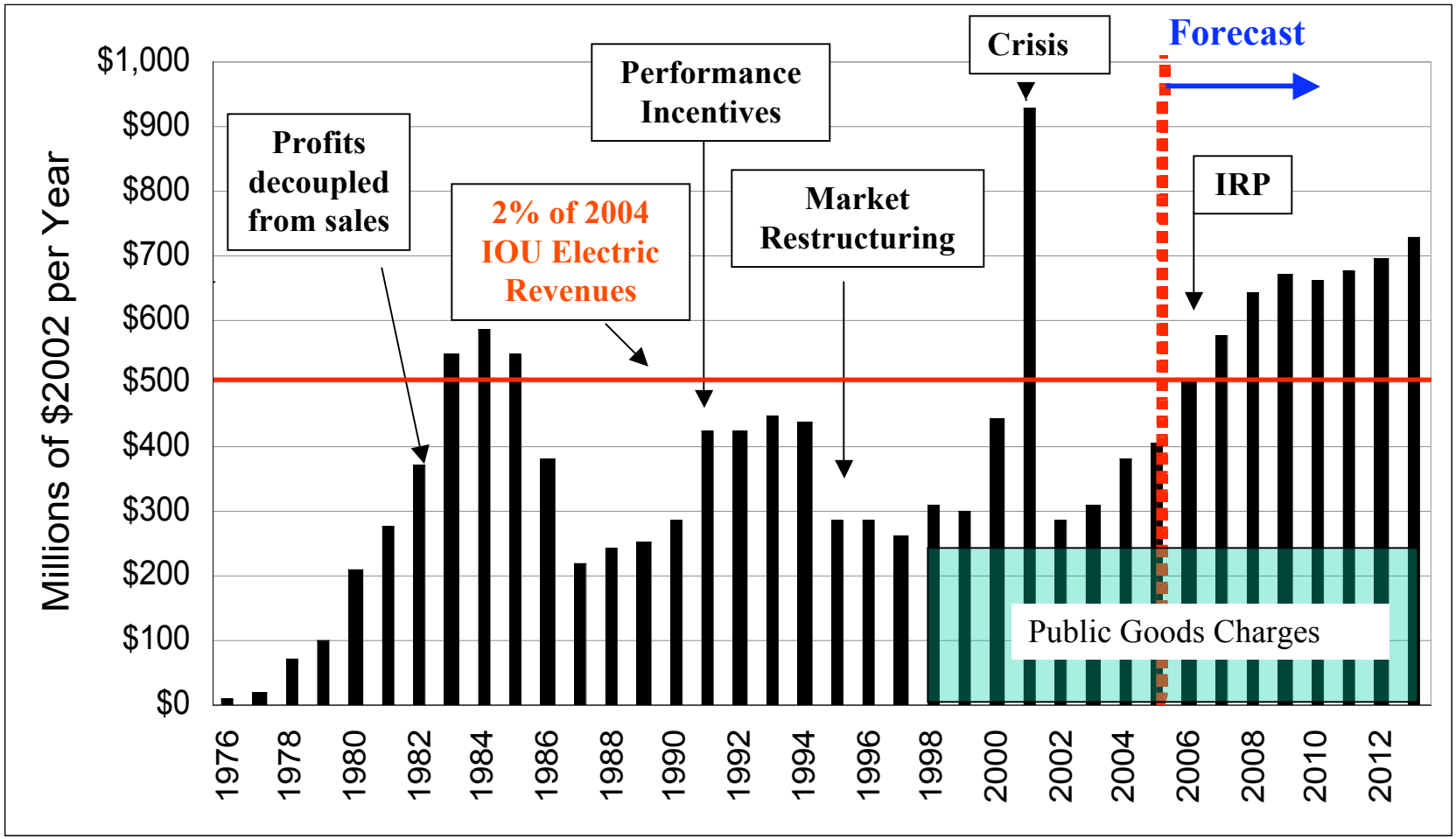

UCLA Department of Astronomy
Jan 31 01 22:52:33

Illuminating Space vs. the Street

Figure 8
Comparison of EE Program Costs to Supply Generation Costs



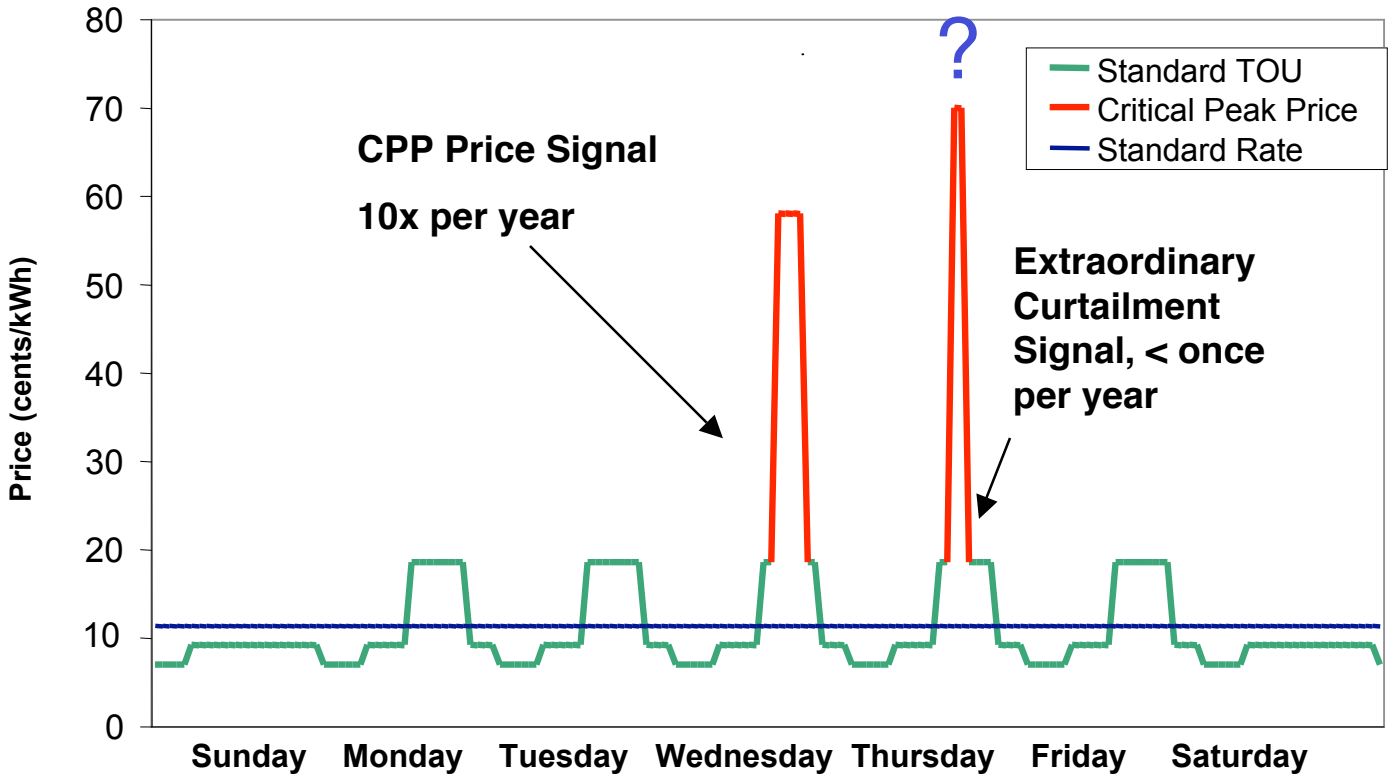
California IOU's Investment in Energy Efficiency



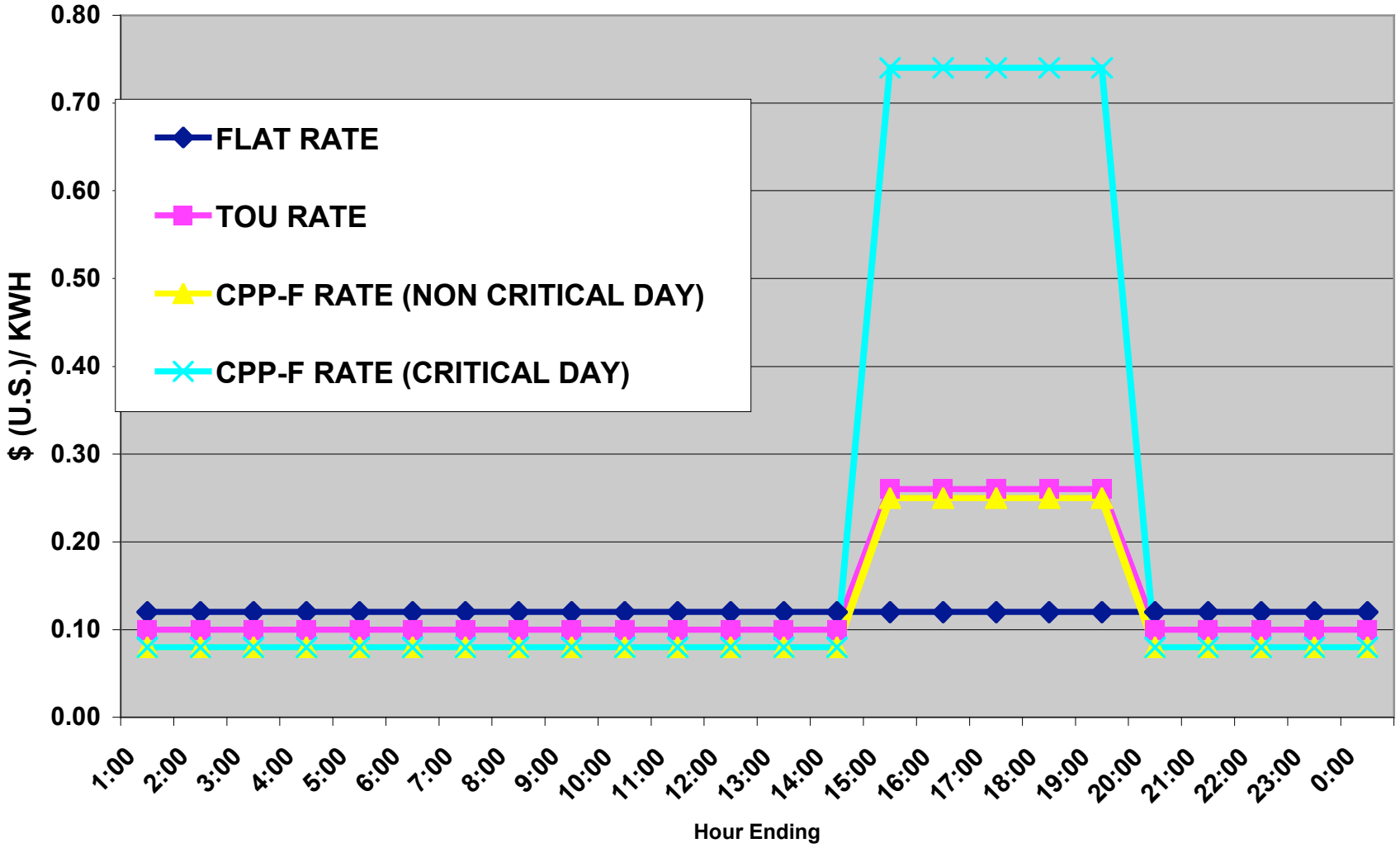
Critical Peak Pricing (CPP)
with additional curtailment option

Potential Annual Customer Savings:

10 afternoons x 4 hours x 1kw = 40 kWh at 70 cents/kWh = ~$30/year



Tariffs being Tested in California Pilot



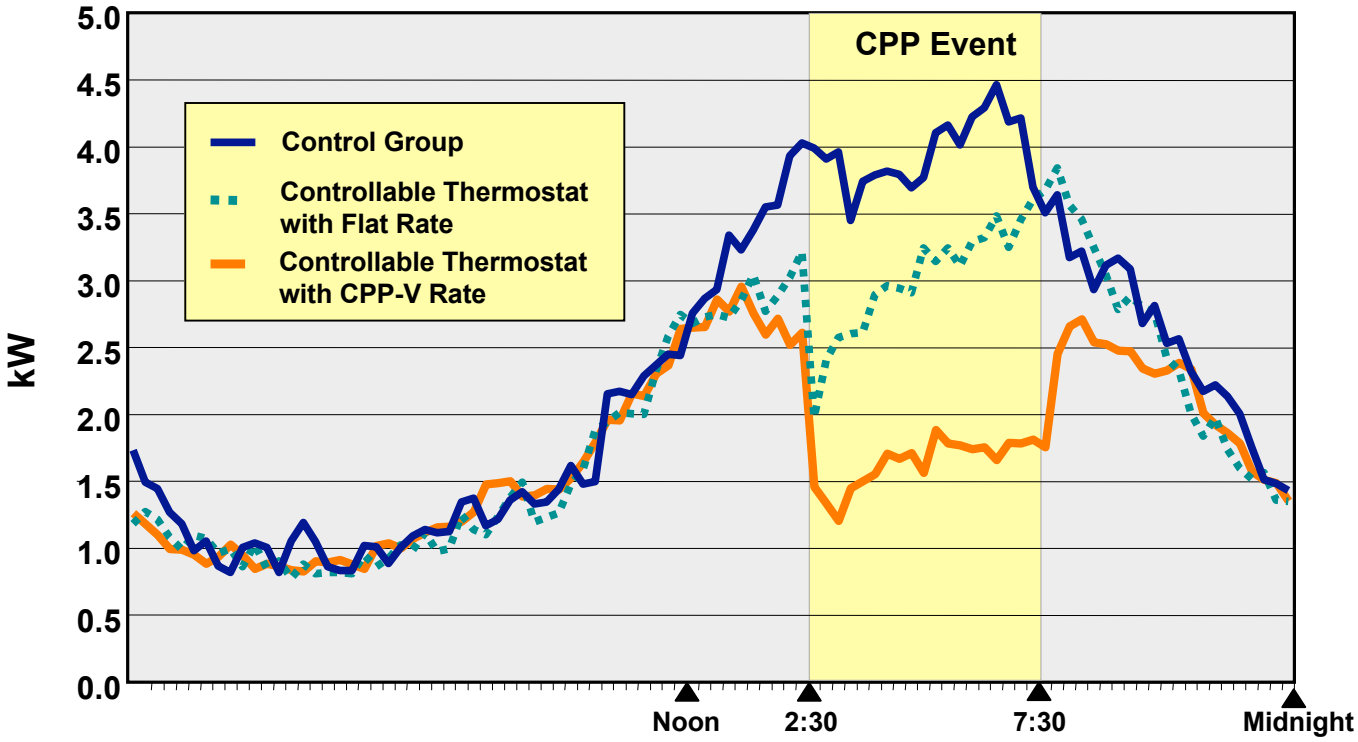
Demand Response, Retail Pricing Pilot, and Advanced Metering Infrastructure

- CPUC and CEC have been testing the impact of "CPP" (Critical Peak Pricing) on demand
  - Two summers of tests ($10 M experiment).
- Results for residential customers
  - 12% reduction when faced with critical peak prices and no technology
  - 30% to 40% reduction for customers with air conditioning, technology, and a critical peak price.
- PG&E and SDG&E will install advanced meters soon

CPP rates – Load Impacts

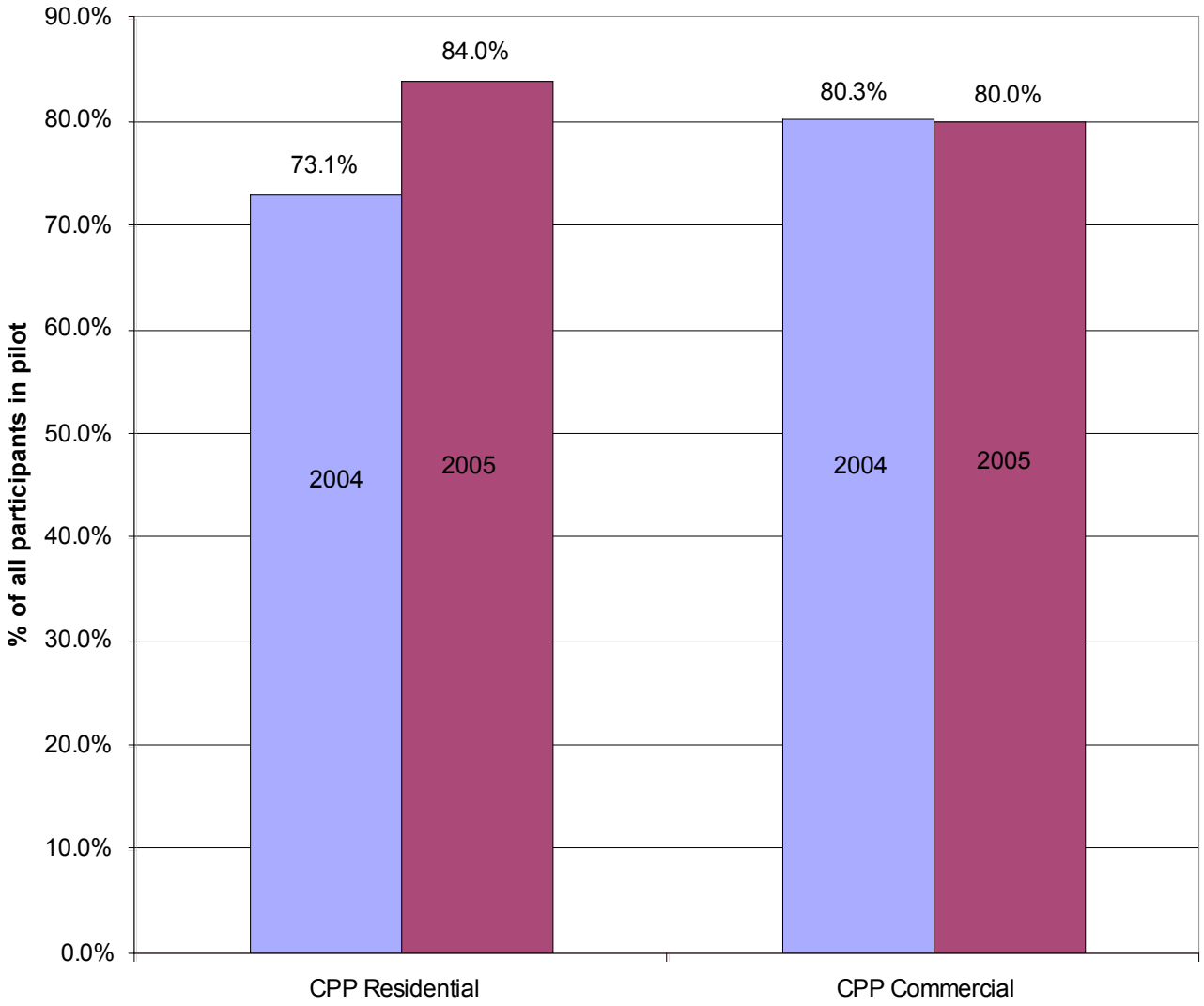
Residential Response on a typical hot day
Control vs. Flat rate vs. CPP-V Rate

(Hot Day, August 15, 2003, Average Peak Temperature 88.5^0)



Source: Response of Residential Customers to Critical Peak Pricing and Time-of-Use Rates during the Summer of 2003, September 13, 2004, CEC Report.

Fraction of Customers on CPP Rates with Lower bills in 2004 and 2005- Residential and Small Commercial

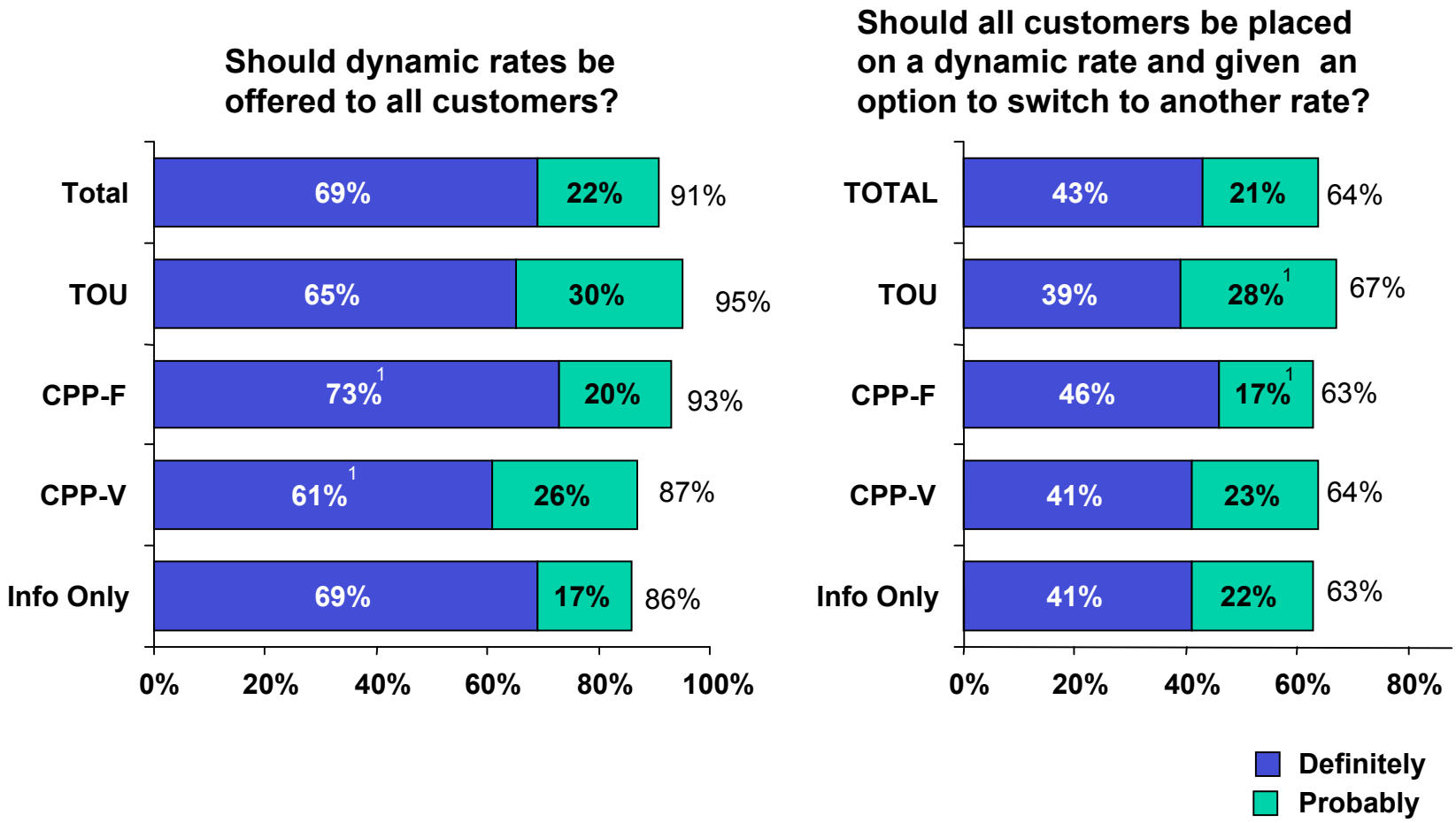


Average residential savings= $38/year

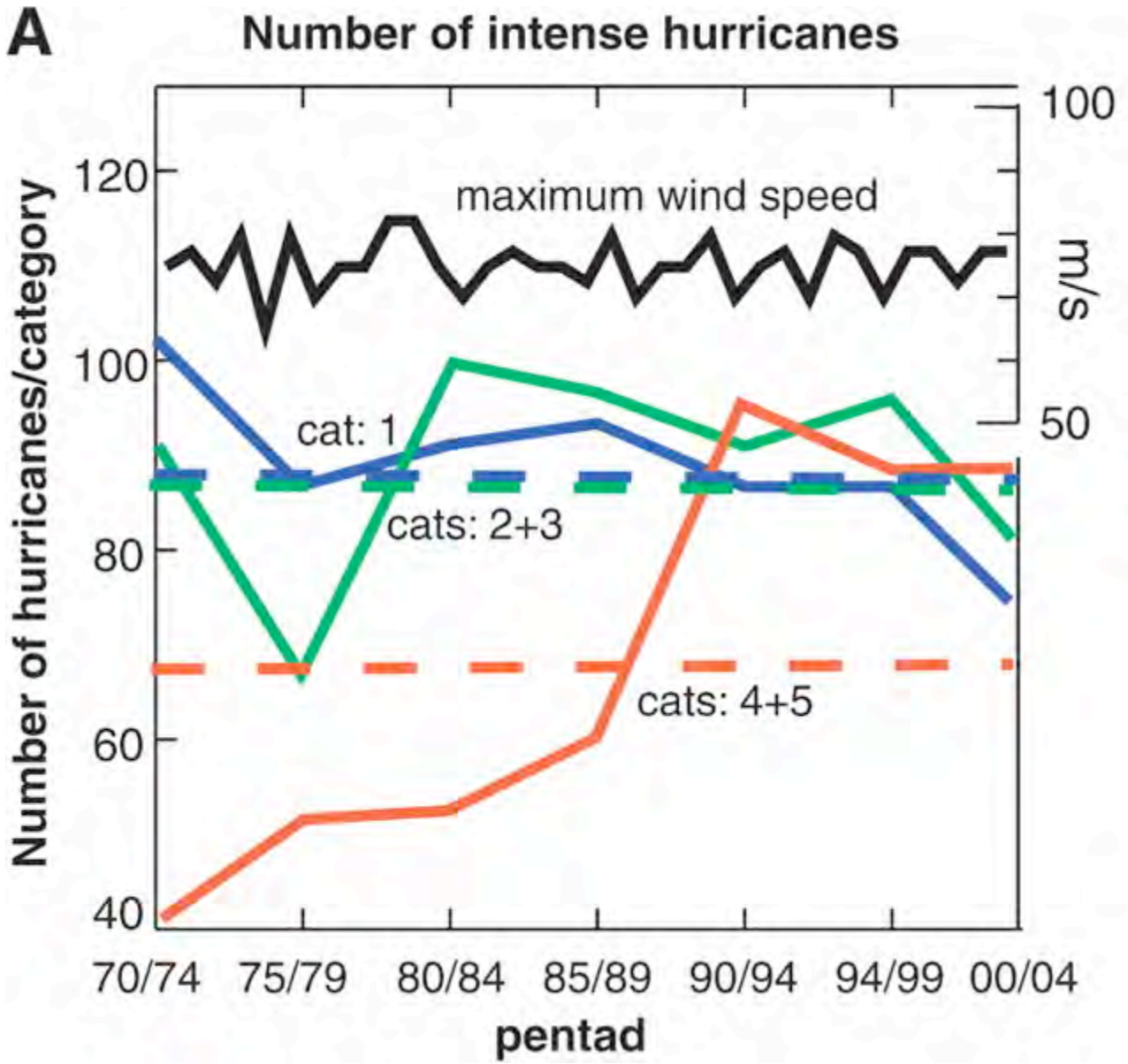
Average small commercial savings-$1300/yr

Customer Acceptance of CPP rates

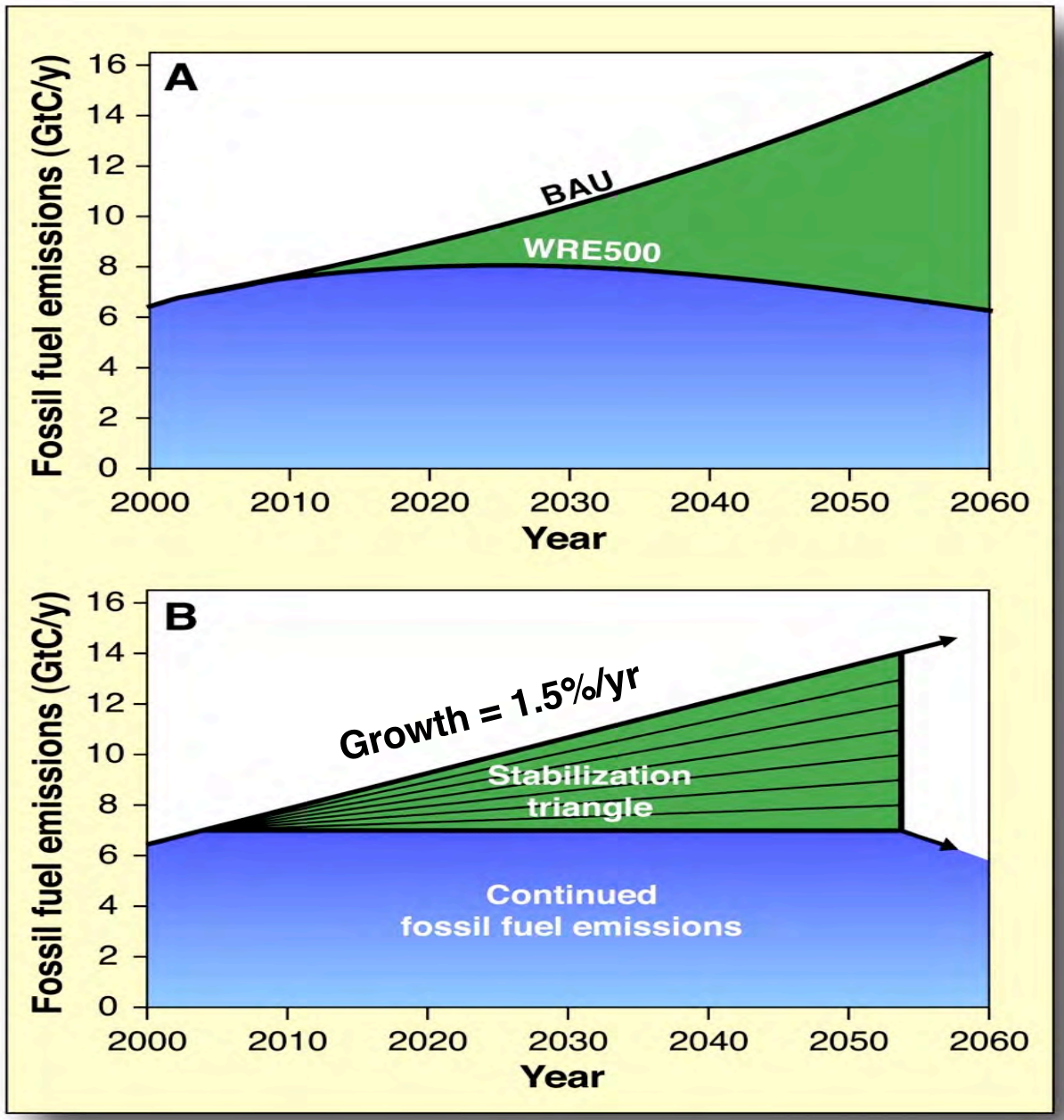
Residential participants express a strong interest in having dynamic rates offered to all customers.



Source: Statewide Pricing Pilot: End-of-Pilot Customer Assessment, December 2004, Momentum Market Intelligence.



Source: Webster, et. al, Science Vol. 309



Source: Stabilization Wedges: Pacala and Socolow, Science Vol 305, page 968